DE2i-150

DEVELOPMENT KIT
WINDOWS USER MANUAL
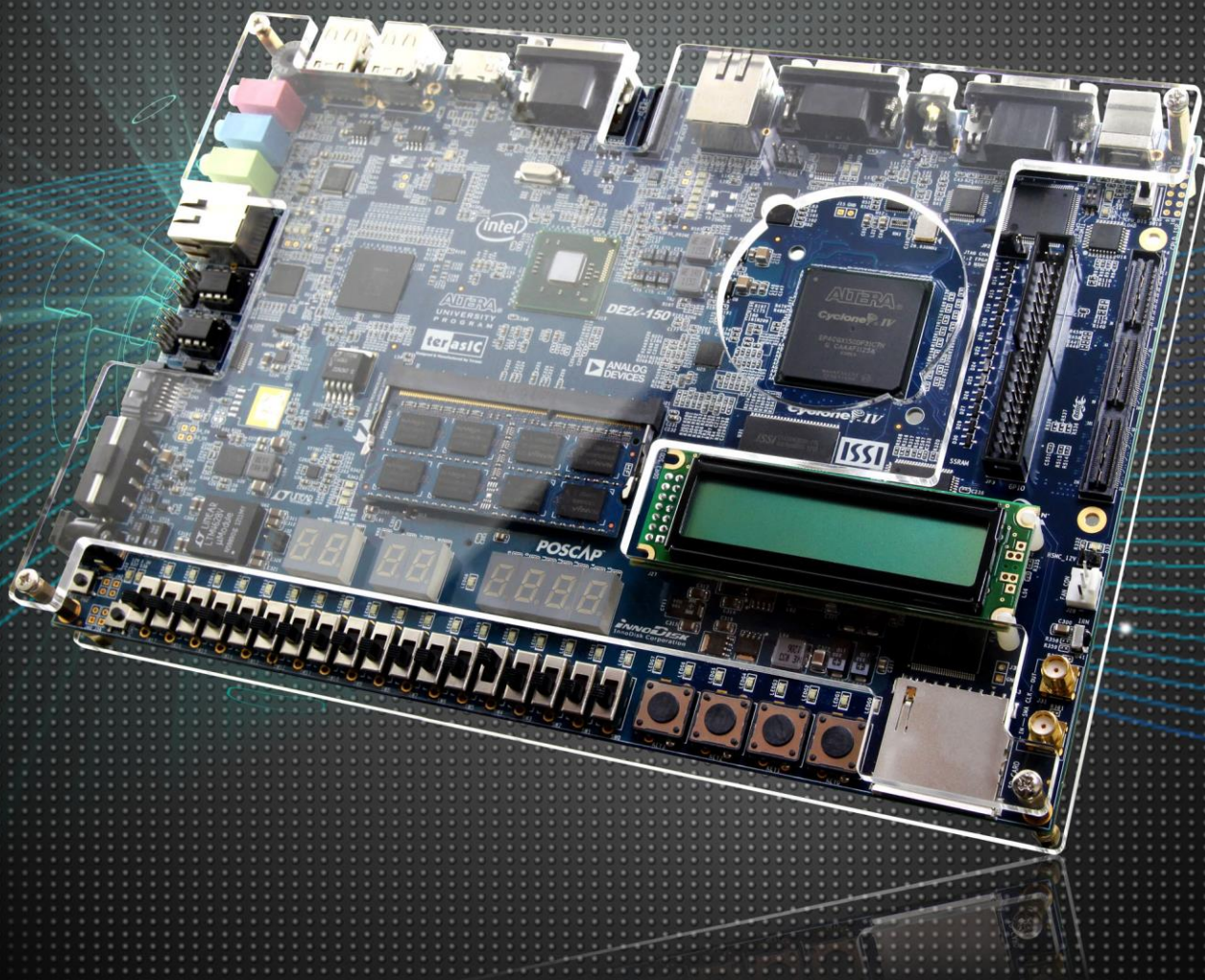
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CONTENTS

Introduction

This document provides an introduction to the installation of Windows 7 to the mSATA SSD (Solid State Drivce) on the DE2i-150 board. Examples of how to develop a C/C++ application program on the system, using the PCI Express channels between the CPU and FPGA, are also provided.

1.1 Requirements

To install Windows to mSATA SSD on DE2i-150, the following items are required:
- Windows 7 installation DVD with license from Microsoft
- USB flash drive, 8GB at least
- Windows based host PC with USB host ports and DVD-ROM.

32-bit Windows 7 is recommended for DE2i-150. The host PC may be running any version of Windows compatible with the tools needed to download and setup the flash drive.

1.2 Develop Windows Program

To develop a C/C++ software program to communicate with FPGA, the following items are required:
- PCI express driver installed (provided by Terasic)
- C/C++ compiler kit. Visual Studio C/C++ 2012 or Borland C++ Builder 6.0 is preferred.

Windows Installation

This chapter will introduce how to use a USB flash drive to install Windows 7 to mSATA SSD on DE2i-150 board.

Items needed are listed below:

● Windows 7 installation DVD (32-bit version is preferred to support different peripherals' drivers).
● USB flash drive (8G or above)
● Host PC equipped with DVD-ROM

In the next section we will introduce how to create a Windows 7 .iso file and put it in a USB flash drive as a boot device.

2.1 Create Windows 7 ISO File

The process described below will convert a Windows 7 .iso image on a CD/DVD to a flash drive. The flash drive can then be used to boot the DE2i-150 or be transferred to the SSD on the DE2i-150 board.

1. There are several software applications available to convert Windows installation DVD to .iso file. A freeware application called "ISO Recorder" is used to create .iso file.
2. Prepare one Windows 7 installation DVD.
3. Download ISO Recorder from http://alexfeinman.com/isorecorder.htm based on your operating system and install it to your host PC.
4. Insert Windows 7 installation DVD to the DVD-ROM of your PC.
5. Open "My Computer" and right-click on the Windows 7 installation DVD to select "Create image from CD/DVD, as shown in **Figure 2-1.**
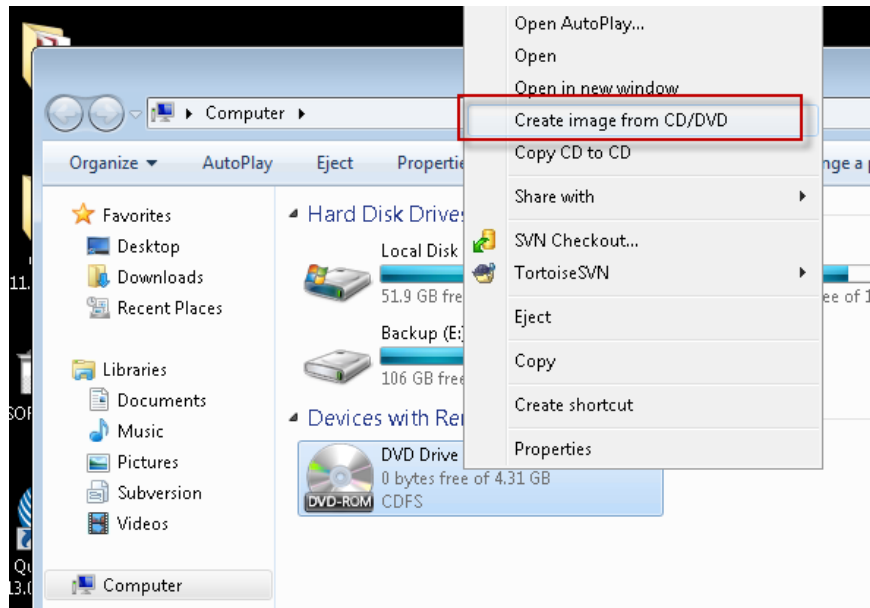
Figure 2-1 Create image from CD/DVD

6. A "Record CD/DVD" window will show up. Select a folder on the host PC and then click "Next".
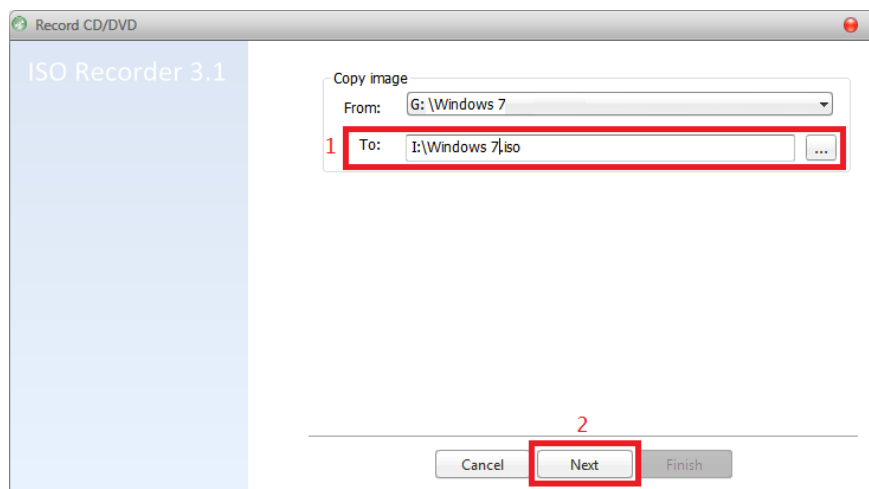

Figure 2-2 Record CD/DVD window

7. Wait for Windows 7 ISO image creation to complete and then click "Finish" to exit.
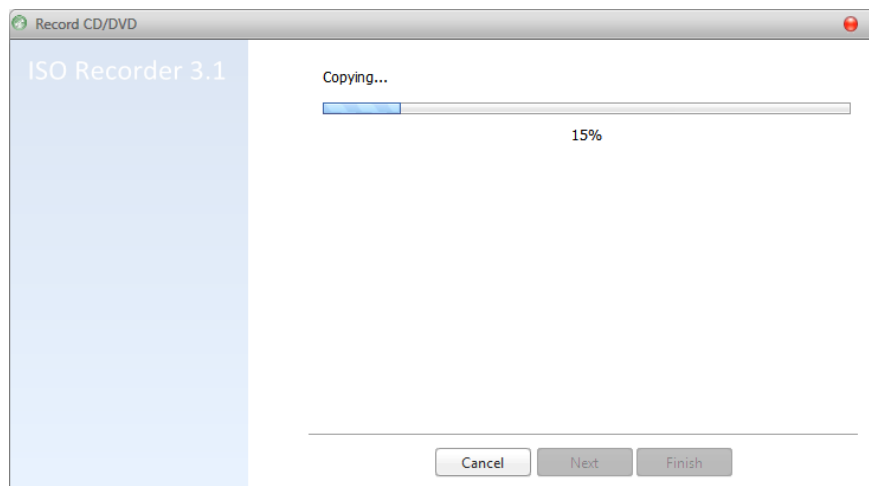
Figure 2-3 Copy files to create .ISO

2.2 Make a Windows 7 Bootable USB Flash Drive

1. After creating the windows 7.iso file, the next step is to copy this .iso file onto a USB drive. We used the "windows7-usb-dvd-tool" software on accomplishing it. The Windows 7 USB/DVD download tool from Microsoft is used to make a Windows 7 bootable device.

2. Download the Windows 7 USB/DVD download tool from http://images2.store.microsoft.com/prod/clustera/framework/w7udt/1.0/en-us/Windows7-USB-DVD-tool.exe.

3. Execute Windows7-USB-DVD-tool.exe to start the installation.

4. Plug in a USB flash drive into your PC.

5. Execute Windows 7 USB DVD Download Tool from the ALL PROGRAMS list by clicking the Windows START button and then Windows 7 USB/DVD Download Tool.
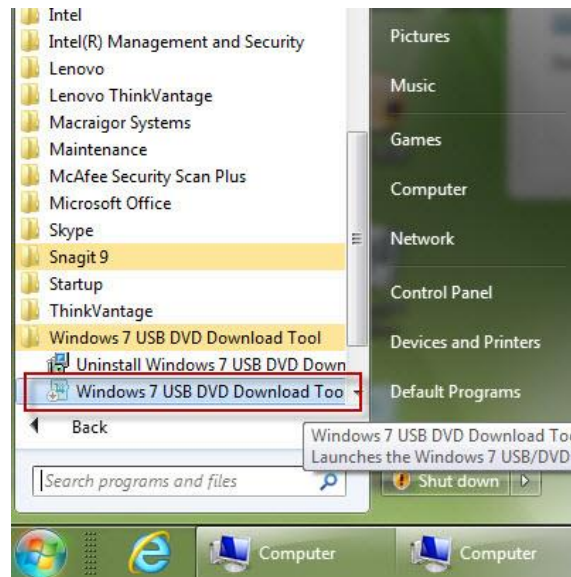
Figure 2-4 Execute Windows 7 USB DVD Download Tool

6. Select the Windows 7 image source file. This file is in the directory that you chose to store in file in Step 6 of the last section. Click Next.
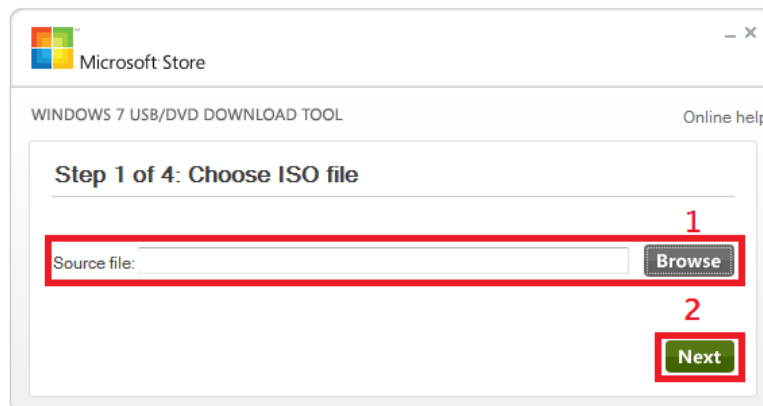

Figure 2-5 Select Windows 7 image source file

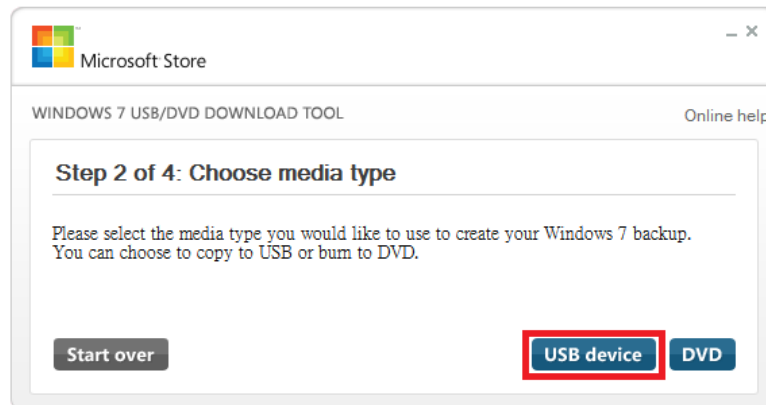7. Select the "USB device" as the media type rather than the DVD.

Figure 2-6 Choose media device

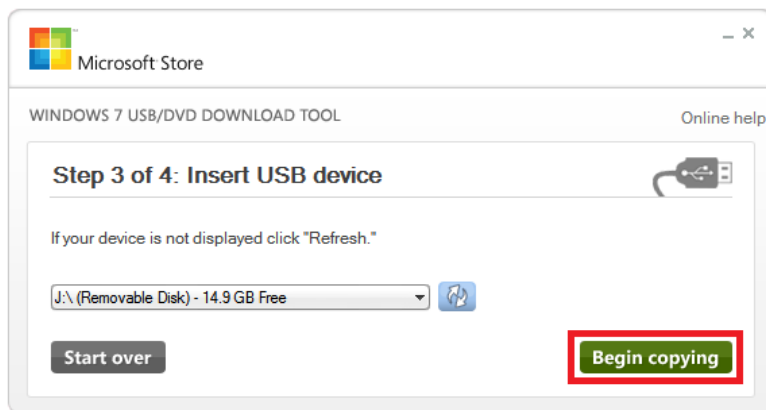8.   When the next window appears, click on "Begin copying".

Figure 2-7 Record CD/DVD window

9.   Click on the "Erase USB Device" option when a pop-up window appears. Please note that any information that was on the Flash drive will be erased.
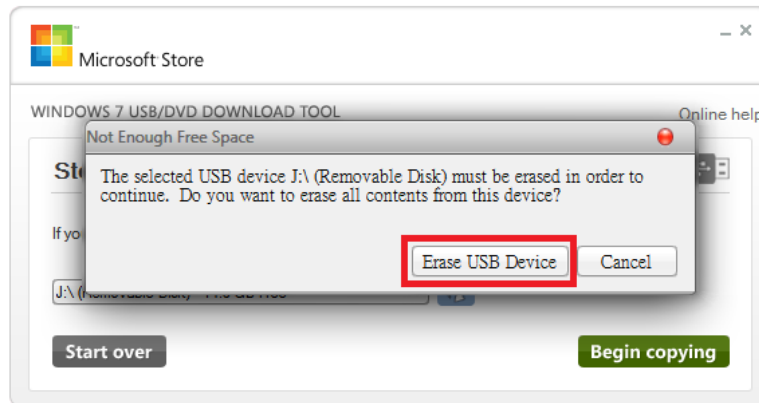
Figure 2-8 Erase USB device
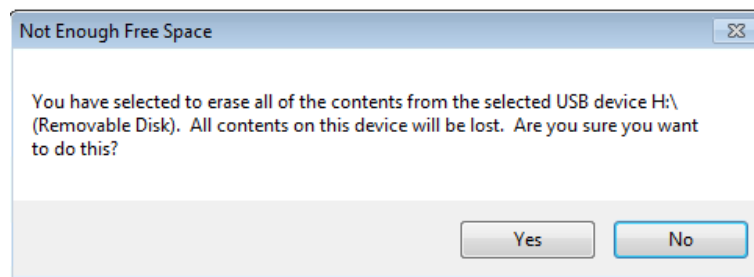
10. Click "Yes" to erase Disk.

Figure 2-9 Erase USB device

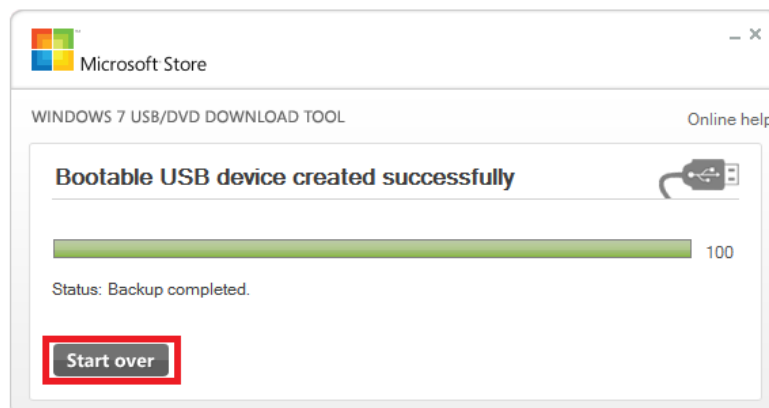11. Wait for bootable USB device creation to finish and then click Start over.

Figure 2-10 Bootable USB device created successfully
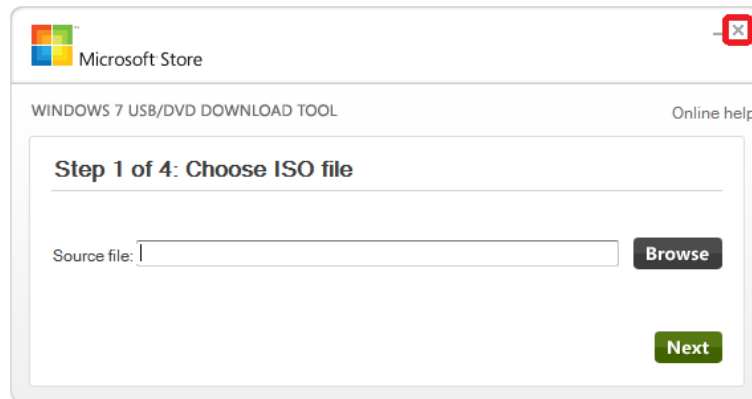
12. Close the tool.

Figure 2-11 Record CD/DVD window

13. The Windows 7 bootable USB flash drive has now been created and is ready to be used with the DE2i-150 board.

2.3 Boot DE2i-150 with Windows 7 Bootable USB Flash Drive

1. Plug in your Windows 7 bootable USB flash drive to one of the USB ports on DE2i-150, as shown in **Figure 2-12**.
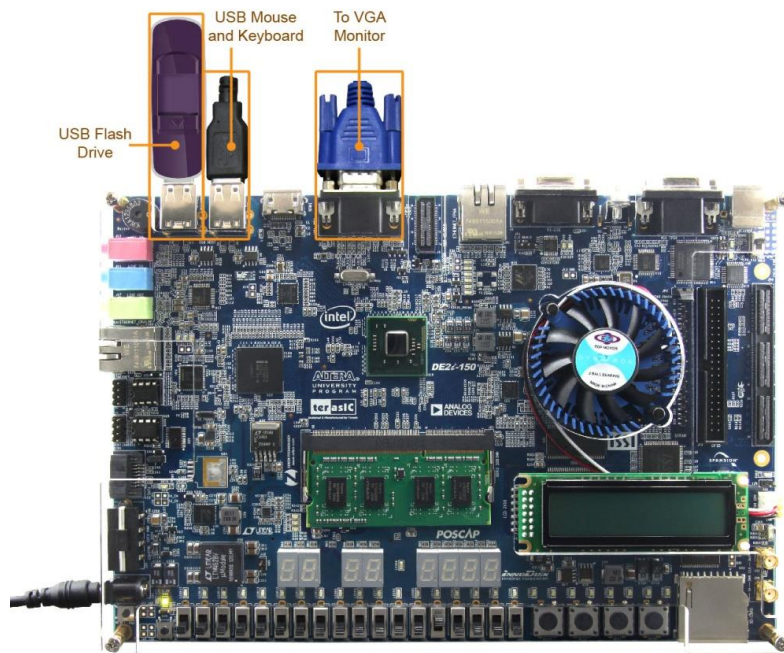
Figure 2-12 Hardware setup for the installation of Windows 7 from USB flash drive

2. Insert the connector(s) for the mouse and keyboard to the other USB ports and connect a monitor with VGA input to the VGA port of DE2i-150.

3. Connect the power adapter to the power jack of the DE2i-150.

4. Press the power on button on the bottom-left corner. The board should power on, emitting some beeps to indicate a successful load of the BIOS.

5. When the BIOS logo is shown on the VGA monitor, press the F10 key on the keyboard to enter the boot menu.
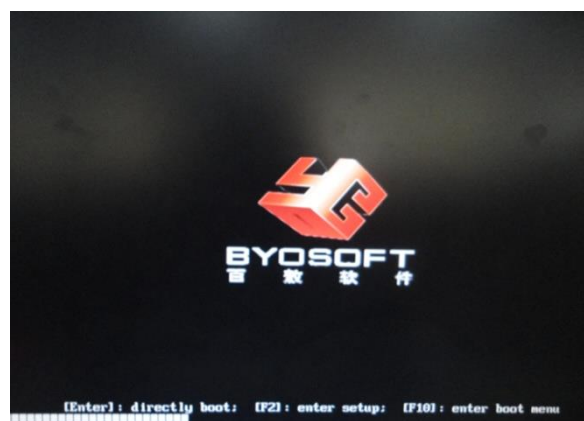

Figure 2-13 BIOS logo

6. Select the USB flash drive that is plugged into the board and press Enter to set the BIOS of DE2i-150 to boot from the USB device.

    Note: Do not select the EFI options.   If you have more than one USB flash drive inserted in the board, please check to make sure that you are selecting the flash drive with the new OS image.
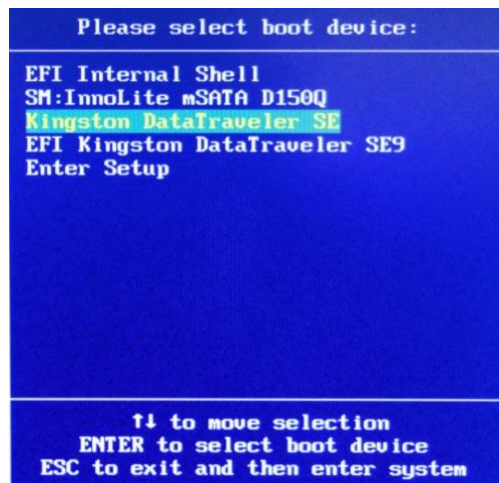

Figure 2-14 Select boot device in BIOS

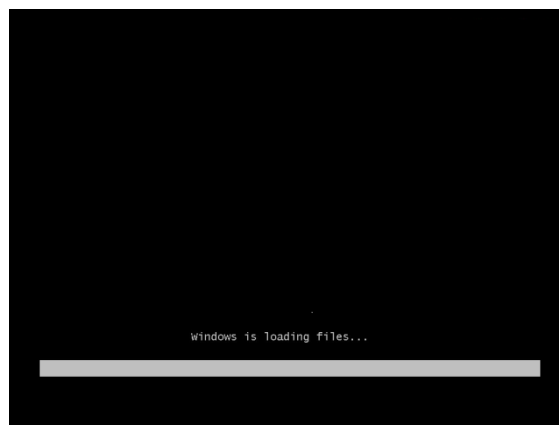7. The DE2i-150 will reboot and enter the Windows loading screen.

Figure 2-15 Windows loading screen

Figure 2-16 Windows installation menu

8. Users can follow the instructions to install the Windows 7.

9. The DE2i-150 will automatically restart several times during the installation of Windows note: Users will need to set the boot device from USB Flash drive back to the mSTAT SSD after the installation is successful (press "F10" when the BIOS logo shows up and set the boot device to "SM:InnoLite mSATA D150Q", as shown in **Figure 2-17)**.
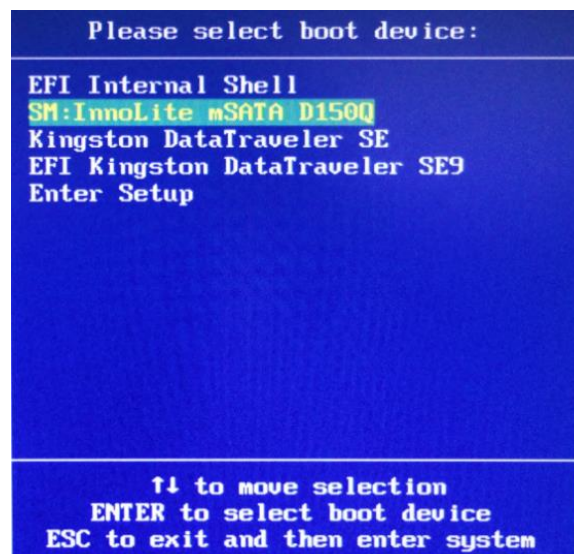

Figure 2-17 Boot Device setup in BIOS

10. The windows 7 driver for the DE2i-150 hardware can be found at http://www.terasic.com/downloads/cd-rom/de2i-150/Drivers_for_CPU_System/.

PCI Express

This chapter will describe how to develop a C/C++ software program to establish communication between CPU and FPGA via PCIe bus in Windows 7 on DE2i-150 board. There are two PCIe demonstrations provided in the DE2i-150 System CD: PCIe Fundamental Demo and PCIe Display Demo. For each demonstration, there are two editions available. One is based on Visual C/C++, and the other is based on Borland C++ builder (BCB). These two editions differ from the compile kit chosen only. The application function is exactly the same.

3.1 PCIe Fundamental Demo

This demonstration illustrates the basic I/O control and high-speed data transfer of PCI Express by by DMA. DMA translation supports both memory types: memory mapping and FIFO. The procedures can be simplified into four major steps:

- Copy demo files to Windows 7
- Install the PCI Express driver
- Programming FPGA and restart Windows 7
- Start the demonstration application software

3.2 Copy Demonstration Files

After Windows 7 has been installed successfully on your DE2i-150 board, users need to copy the demonstrations files from the DE2i-150 System CD to Windows 7 through an external USB storage before running this demonstration. The PCIe Driver must also be installed on the DE2i-150 board for the demonstration to work properly. Here are the major copy procedures:

1. Prepare a USB storage and connect it to your host PC.
2. Copy the folder "**Demonstrations/PCIe_SW_KIT/Windows/PCIe_DriverInstall**" from

the DE2i-150 System CD to the USB storage.

3. Copy the folder "**Demonstrations/FPGA/PCIE_Fundamental**" from the DE2i-150 System CD to the USB storage.

4. Remove the USB storage from your host PC and plug it into the USB port of your DE2i-150 board.

5. Copy both folders **PCIe_DriverInstall** and **PCIe_Fundamental** from the USB-storage to the mSATA SSD.

3.3 Install PCI Express Driver

This section will describe how to install PCIe drivers for Windows 7 on DE2i-150 board. The procedures of PCIe driver installation for this demonstration are:

1. Open the **PCIe_DriverInstall** folder copied from the DE2i-150 System CD.
2. Execute PCIe_DriverInstall.exe and click **Install** button, as shown in **Figure 3-1**.
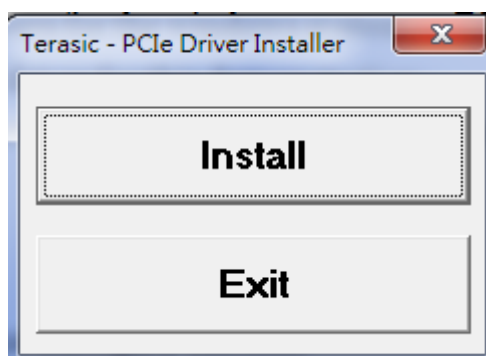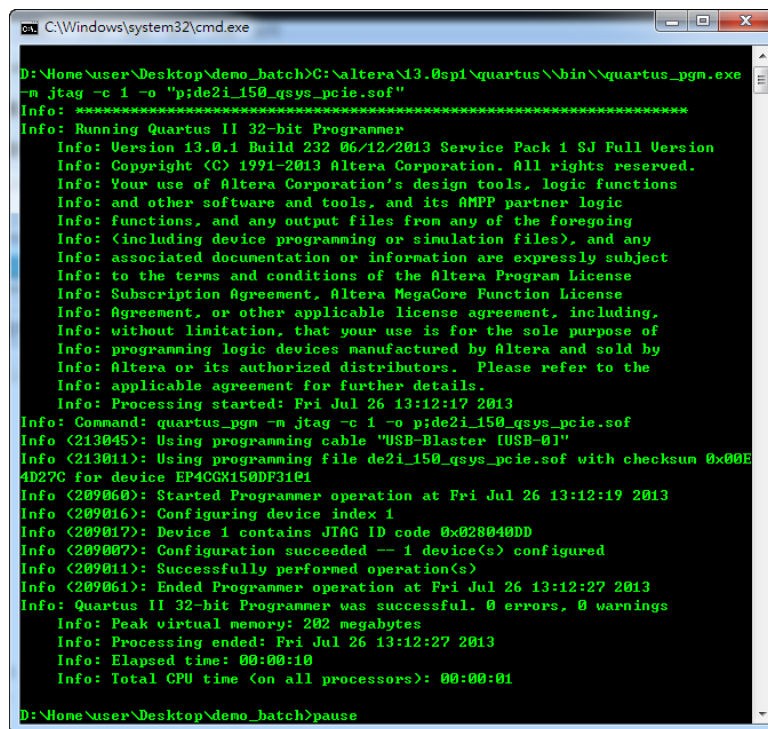3. After the driver is installed, click the **Exit** button.

Figure 3-1 PCIe driver installation window

3.4 Program FPGA and Restart Windows 7

Before Windows can detect the FPGA on the DE2i-150 via the PCIe bus, the FPGA must first be configured using the demonstration .sof file. After the FPGA is configured, the system should be restarted, so that the BIOS can detect the FPGA and Windows 7 can communicate with the FPGA through the PCIe port.

The procedures to configure FPGA with the demonstration .sof file from a Windows based host PC (*Note) are:

1. Install the Altera Quartus II tools on your host PC.
2. Set SW19 to RUN position and the CPU DIS of SW20 to OFF position.
3. Use a USB cable to connect the host PC and the USB-Blaster port on the DE2i-150 board.
4. Copy the folder "**Demonstrations/FPGA/PCIe_Fundamental/demo_batch**" to your host PC.
5. Execute the "**sof_download.bat**" file in the "**demo_batch**" folder to start the FPGA configuration process.
6. When the configuration is successful, you will see a message shown in **Figure 3-2**.
7. Restart Windows 7 to allow the BIOS to detect FPGA via PCIe bus. This can be done without powering down the DE2i-150 board by using the restart function in Windows or using the reset button on the CPU.

Figure 3-2 FPGA configuration is successful

8. After Windows 7 restarts, open the Windows 7 Device Manager. The FPGA device can be viewed using the Windows device manager as shown in **Figure 3-3.**
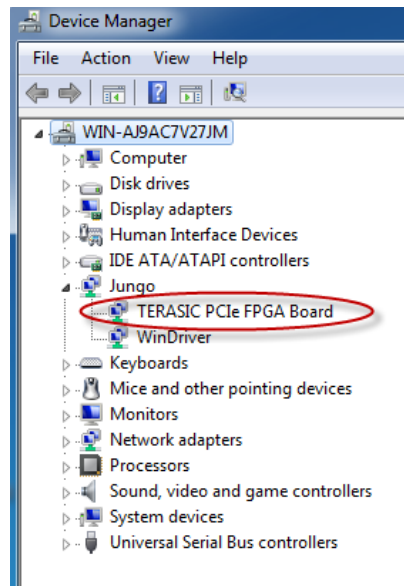
Figure 3-3 Terasic PCIe FPGA board is detected in device manager

*Note : Users can also install Quartus II and the USB driver to Windows 7 on the DE2i-150 board. The demonstration .sof file can be downloaded from there to FPGA on DE2i-150 board instead of using a separate host PC.

3.5 Start Demonstration Application Software

Once the PCI Express driver is successfully loaded and the image has been loaded into the FPGA, the application software can be executed following the procedures below:

1. Open the **PCIe_Fundamental/windows_app_vc2012/Release** folder which is copied from a USB storage and execute "app.exe". The program will display a menu shown in **Figure 3-4**. To execute binary file built in BCB6 (Borland C++ Builder 6.0), please execute "app.exe" from the folder **PCIe_Fundamental /windows_app_bcb6/OUTPUT.**

Figure 3-4 PCIe fundamental demo menu

2. For the LED demo, please type "0" and press "ENTER" to enter the LED control mode. The program will show "Please input led control mask:" to query users input a control mask, as shown in **Figure 3-5**. Users can input a decimal value between 0 ~ 15 to control the four LEDs (LEG0/ LEDG1/ LEDG2/ LEDG3) on DE2i-150 board. The value 15 will light up four LEDs. The value 11 will light up LEDG0 only. The value 0 will turn off four LEDs.

Figure 3-5 Led control demo

3. For the button status demo, please type "1" and press "ENTER". The program will report the status of KEY0/KEY1/KEY2/KEY3 as a heximal value. If there's no key pressed, the status value is fh, as shown in **Figure 3-6**. If KEY0 is pressed, the status value is eh.

Figure 3-6 Button status read demo

4. For the DMA memory test, please type "2" and press "ENTER". The program will report the test result, as shown in **Figure 3-7**.

Figure 3-7 DMA memory test demo

5. For the DMA FIFO test, please type "3" and press "ENTER". The program will report the test result, as shown in **Figure 3-8**.

Figure 3-8 DMA FIFO test demo

6. To quit this demonstration program, please type "99" and press "ENTER".

3.6 PCIe Display Demo

This demonstration illustrates the basic I/O control and high-speed data transfer of the PCI Express bus. The setup procedures can be simplified into four major steps:

- Copy demo files to Windows 7
- Install the PCI Express driver (please refer to the previous section)
- Programming FPGA and restart Windows 7
- Start the demonstration application software
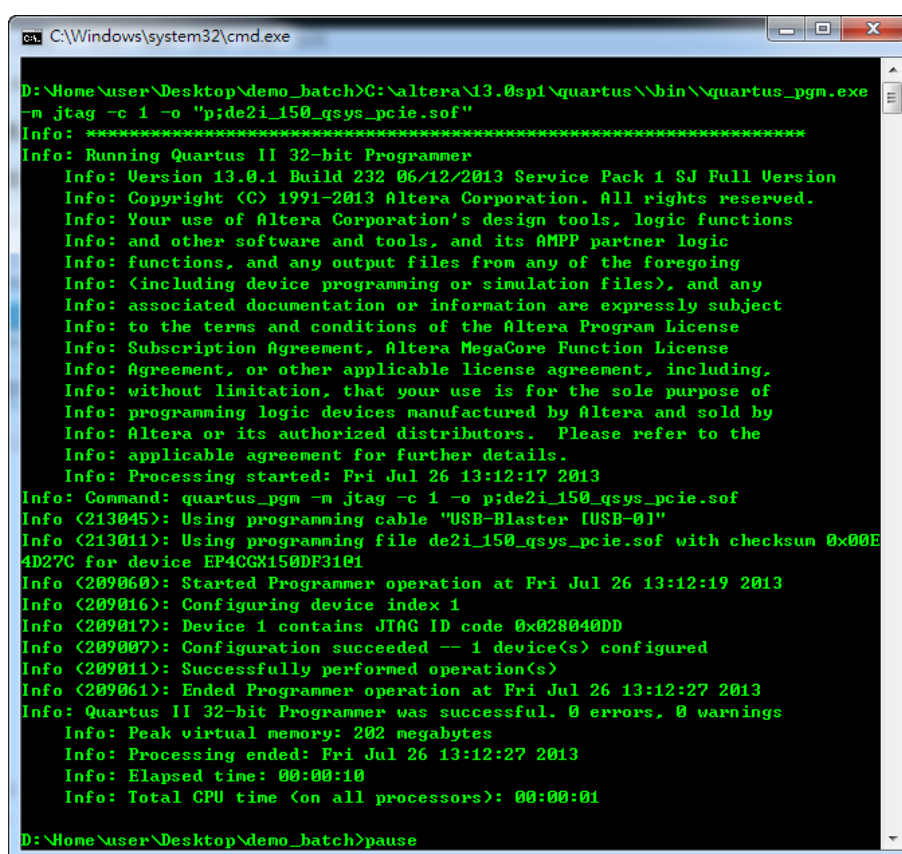
3.7 Copy Demonstration Files

The demonstrations files are copied from the DE2i-150 System CD to Windows 7 through an external USB storage. The procedure to perform this operation is:

1. Prepare a USB storage device and connect it to your host PC (which may be the DE2i-150 as described in the previous section).
2. Copy the folder "**Demonstrations/PCIe_SW_KIT/Windows/PCIe_DriverInstall**" from the DE2i-150 System CD into the USB storage.
3. Copy the folder "**Demonstrations/FPGA/PCIe_Display**" from DE2i-150 System CD to the USB storage.
4. Remove the USB storage from your host PC and plug it to the USB port of DE2i-150.
5. Install the USB storage device and power on the DE2i-150 board.
6. Copy both the **PCIe_DriverInstall** and **PCIe_Display** folders from the USB storage to the mSATA SSD.

3.8 Program FPGA and Restart Windows 7

Before Windows can detect FPGA on DE2i-150 via PCIe bus, users need to configure the FPGA with the demonstration .sof file first. After FPGA is configured, system should be restarted, so the BIOS can detect the FPGA and allow Windows 7 to communicate through the PCIe port with the FPGA. The procedure to configure FPGA with the demonstration .sof file from your Windows based host PC (***Note**) is:

1. Altera Quartus II must be installed on your host PC.
2. Use a USB cable to connect your host PC and the USB-Blaster port on the DE2i-150 board.
3. Copy the folder "**Demonstrations/FPGA/PCIe_Display/demo_batch**" to your host PC.
4. Execute "**sof_download.bat**" in the "**demo_batch**" folder to start the FPGA configuration process.
5. When the configuration is successful, you will see a message as shown in **Figure 3-9**.

Figure 3-9 FPGA configuration is successful

6. Restart Windows 7 to allow the BIOS to detect the FPGA via PCIe bus. This can be done by using the restart function in Windows or using the reset button on the CPU.
7. After Windows 7 restarts, the FPGA device can be viewed using the device manager window shown in **Figure 3-3.**

3.9 Start Demonstration Application Software

When the PCI Express driver is loaded successfully, the application software can be executed following the procedure outlined below:

1. Connect an LCD monitor to the FPGA VGA port (J8).

2. Open the **PCIe_Display/windows_app_vc2012/Release** folder copied from the USB storage and execute the "app.exe". The program will start to transfer image pattern by DMA and the progress is shown in Figure 3-10. To execute the binary file built by BCB6 (Board C++ Builder 6.0), please execute the "app.exe" from the folder **PCIe_Display/windows_app_bcb6/OUTPUT** folder.

Figure 3-10 Image data transfer by DMA

3. Users will also see two test patterns alternatively displayed on the monitor, as shown in Figure 3-11.

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Figure 3-11 Two test patterns

4. Press Ctrl+C to terminate the program.

3.10 Compile PCIe Project

This section will describe how to open the application projects and compile them. For each of the PCIe demonstrations in the DE2i-150 System CD, the application software project can be created using one of these two compiler kits: Visual C/C++ 2012 and Borland C++ Builder 6.0. The function of both projects is identical, so developer can select a preferred compilation kit. The procedures to compile the application software for the "**PCIe Fundamental Demo**" is shown below. Developers can build another application software of "**PCIe Display Demo**" using the same procedures.

3.11 Visual C/C++ 2012

The procedures below show how to open the Visual Studio C/C++ project and compile it.

1. Please make sure Visual Studio C/C++ 2012 has been installed on your host PC.
2. Copy the folder "**Demonstrations/PCIe_Fundamental/windows_app_vc2012**" from the DE2i-150 system CD to your host PC.
3. Launch the Visual Studio 2012.
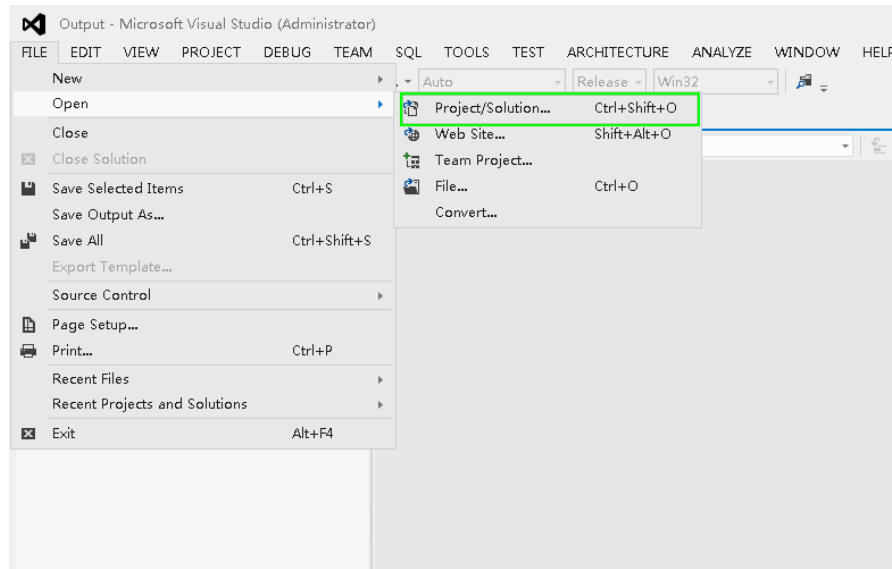4. Click "File → Open → Project/Solution", as shown in **Figure 3-12**.

Figure 3-12 Menu of Visual Studio 2012

5. Go to the **windows_app_vc2012** folder and select the project "app.vcxproj", as shown in **Figure 3-13**.
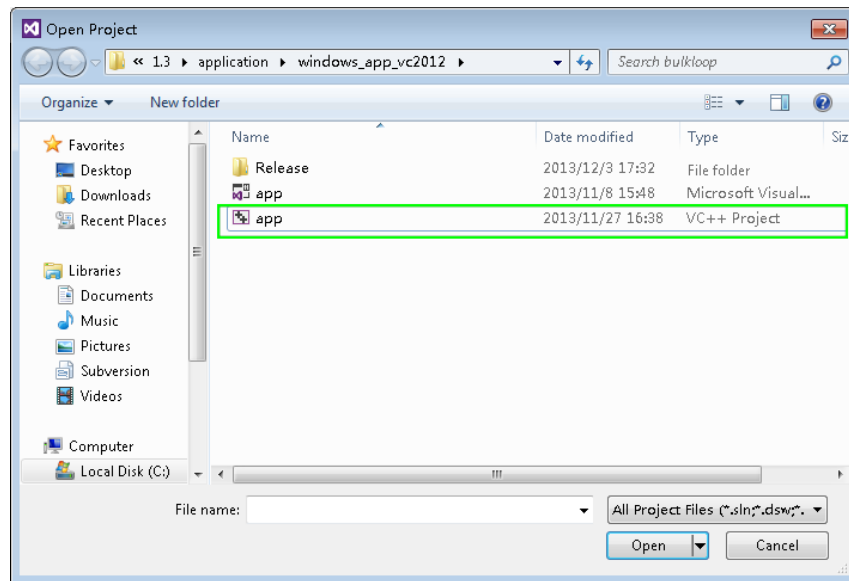

Figure 3-13 Open the project in Visual Studio 2012

6. Right-click on the project "**app**" from the "**Solution Explorer**" to launch the popup menu and select "**build**" item to build the project as shown in **Figure 3-14**.
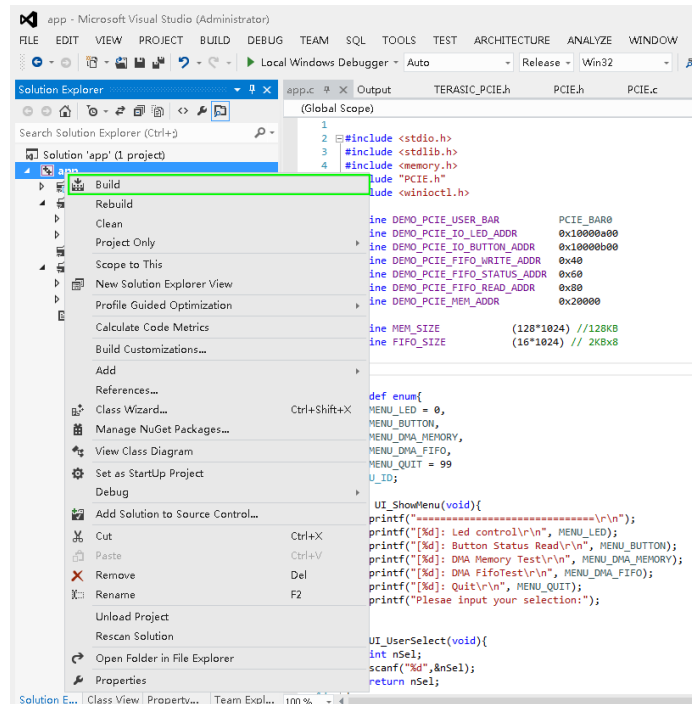
Figure 3-14 Build the project in Visual Studio 2012

7. An executable file "**app.exe**" will be generated under the "**Release**" folder if the build process is successful.

3.12 Borland C++ Builder 6.0

The procedures below show how to open a BCB project and compile it.

1. Please make sure that BCB6 (Borland C++ Builder 6.0) has been installed on your host PC.

2. Copy the folder "**Demonstrations/PCIe_Fundamental/windows_app_bcb6**" from the DE2i-150 system CD to your host PC.

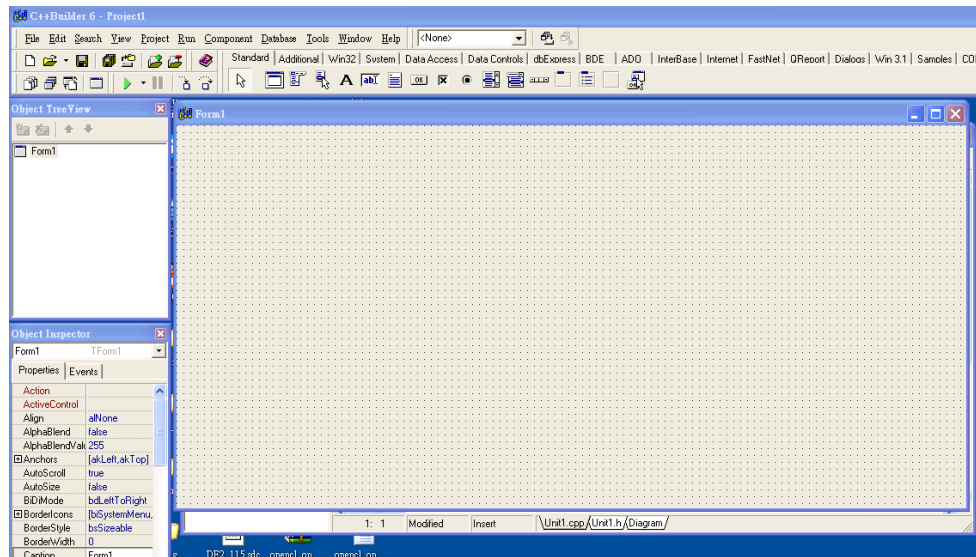3. Open Borland C++ Builder, as shown in **Figure 3-15**.

Figure 3-15 Borland C++ Builder 6.0 IDE

4. Click "File → Open Project". When the "Open Project" dialog appears, go to the **windows_app_bcb6** folder and select "app.bpr", as shown in **Figure 3-16**.
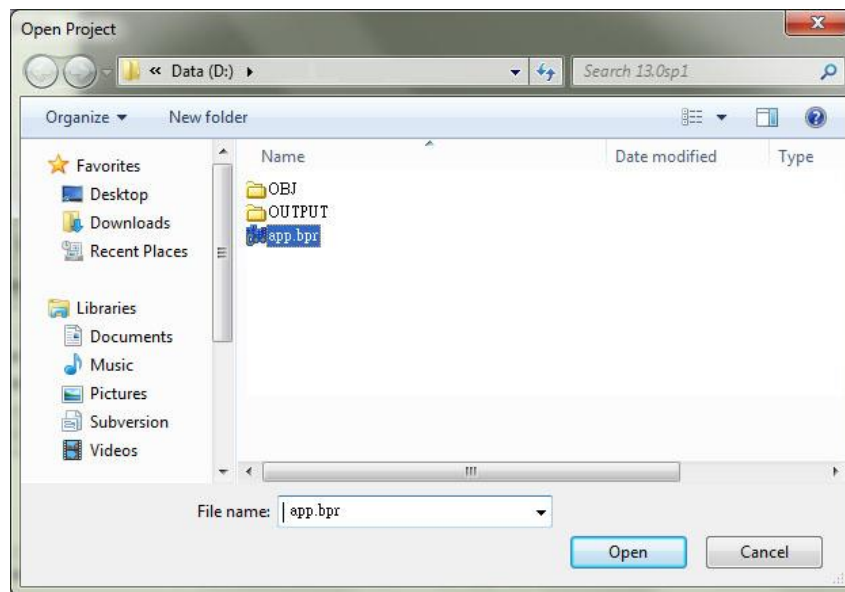

Figure 3-16 Open the project in Borland C++ Builder 6.0

5. Click "**Project**" and select "**Build app**" to build the project, as shown in **Figure 3-17**, to generate an execution file app.exe.
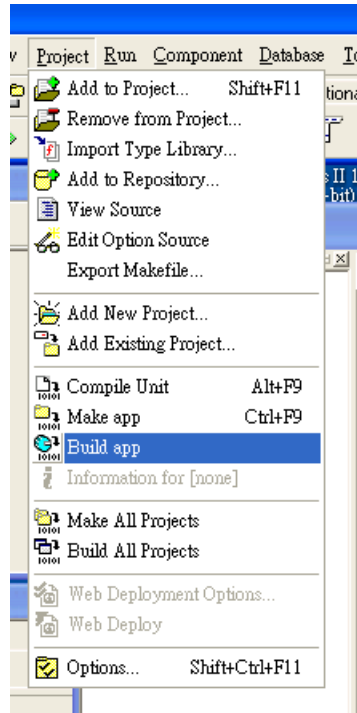
Figure 3-17 Build the project in Borland C++ Builder 6.0

6. An executable file "**app.exe**" will be generated under the "**OUTPUT**" folder if the build process is successful.

Additional Information

Getting Help

Here is the contact information where you can get help if you encounter problem:

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Revision History

Date	Version	Changes
2013.7	First publication	