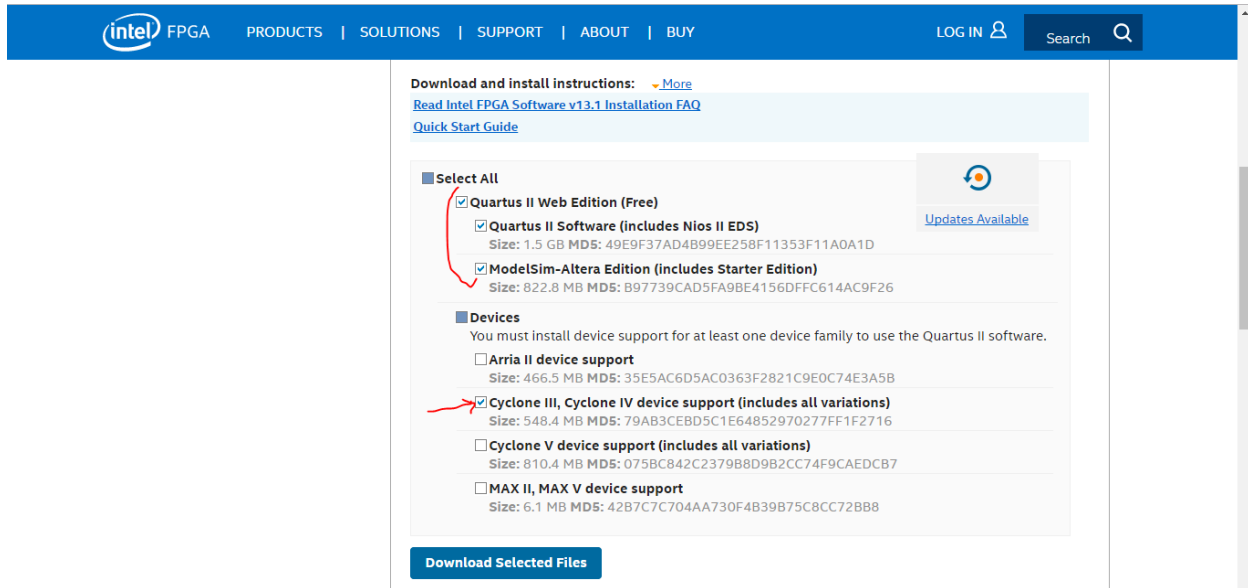


D5M Camera Setup/Tutorial

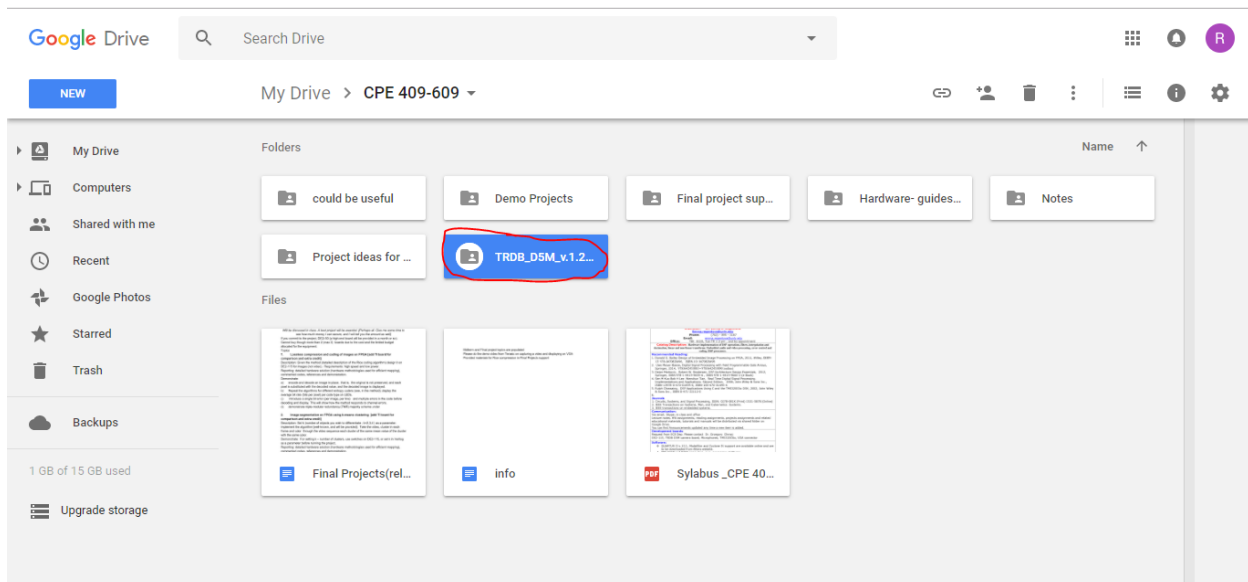
Video Link: <https://youtu.be/3lM6eXkLEoU>

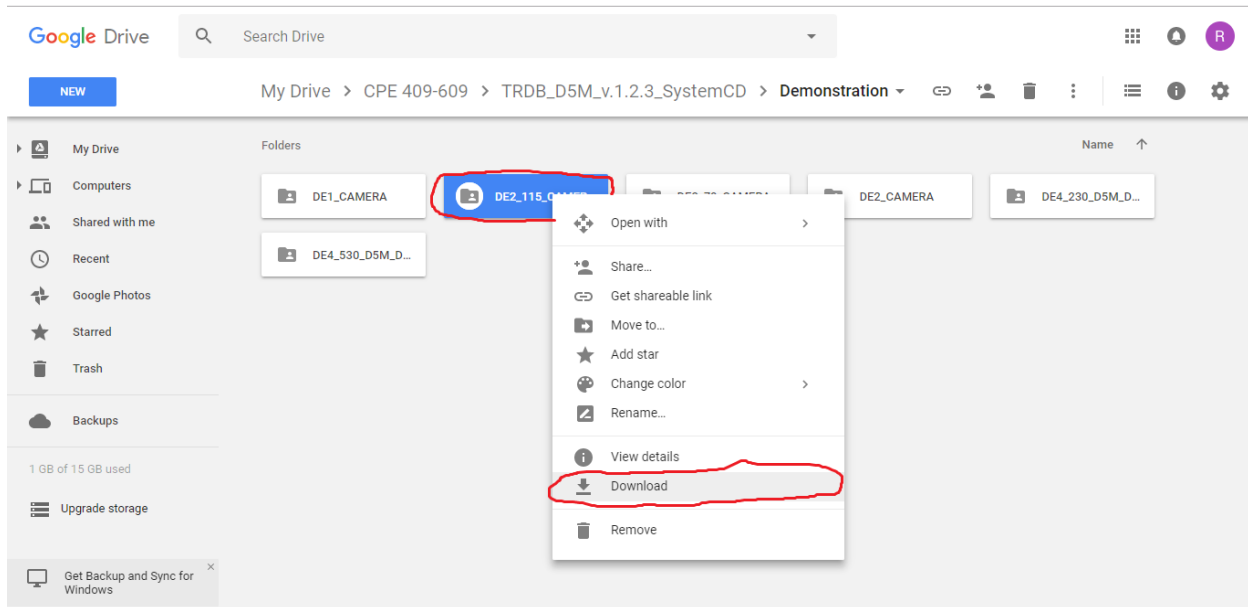
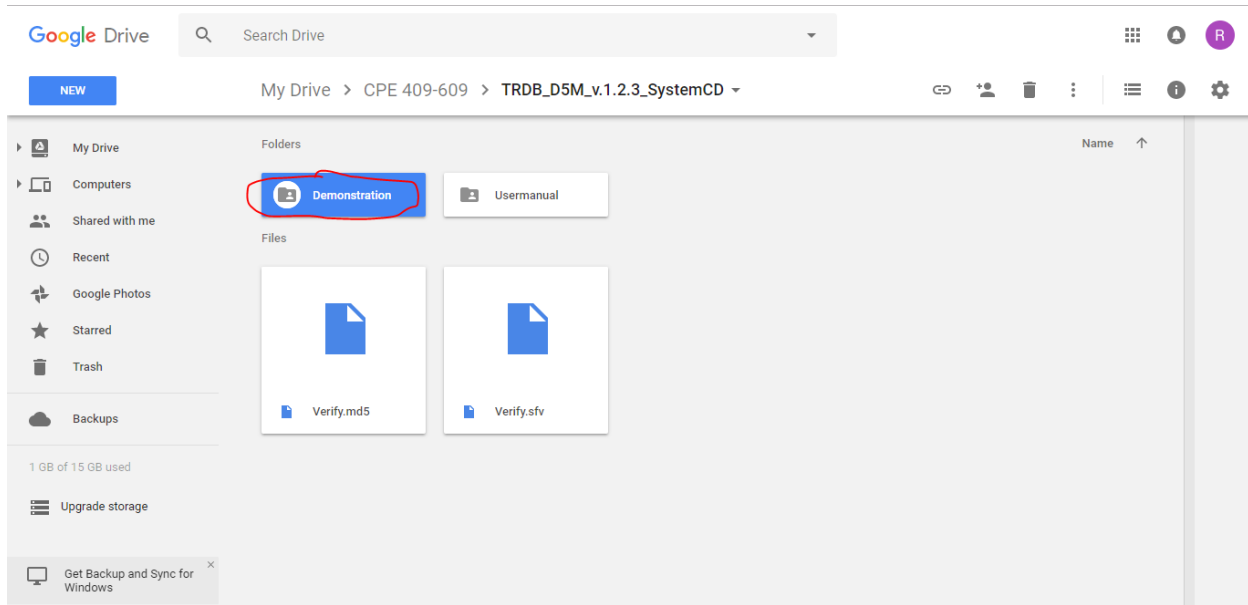
1. If you are using your own machine (Windows 7 or greater), download Quartus II 13.1 from this website: <https://dl.altera.com/13.1/?edition=web>



Make sure you download these checked files at a minimum. All other options are optional. After you click **Download Selected Files**, it will ask you to sign up for an account.

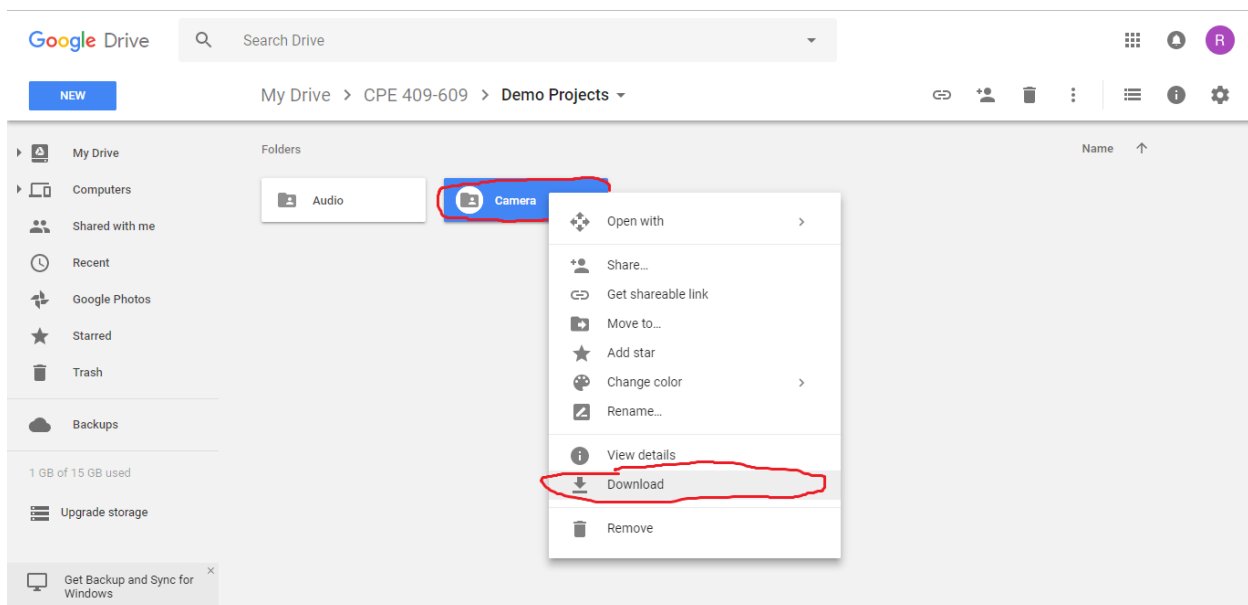
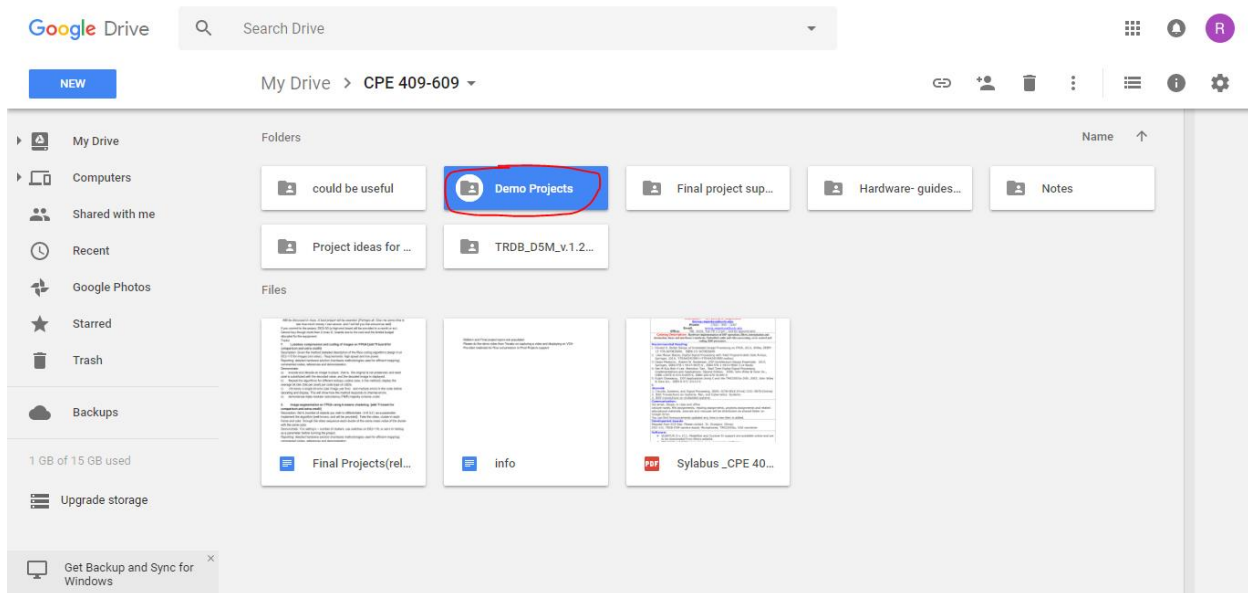
2. After you install Quartus II 13.1, go to the **CPE 409-609** folder on Google Drive. Click on the **TRDB_D5M_v.1.2.3_SystemCD** folder and then go to the **Demonstration** directory. Afterwards, download the **DE2_115_CAMERA** folder by right clicking on the folder and pressing Download.





Afterwards, unzip this folder to the Desktop (or any location you like). We will come back to this folder in a bit. Note that this folder is used heavily to interact between the DE2-115 and D5M camera. More details later in this tutorial. Before getting started, we just need one more folder to download for running the class's demo projects.

- Head back to the **CPE 409-609** folder, and go to the **Demo Projects** folder. Download the **Camera** folder.



Then, unzip this folder to the Desktop (or any location you like).

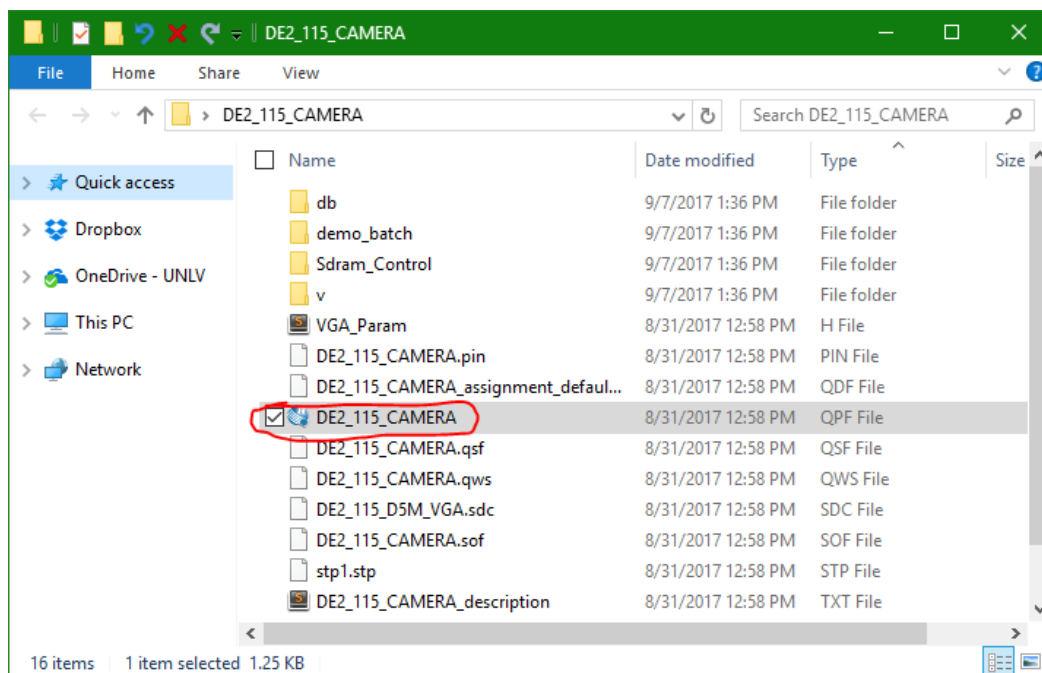
- At this point, you should have two folders: **DE2_115_CAMERA** and **Camera**. As mentioned earlier, the **DE2_115_CAMERA** folder is the Terasic's Quartus project for the D5M camera, so this is the basis for projects involving the DE2-115 board and the D5M camera. Any modifications that you do to this must be done in a different folder. This means make a new copy of the folder any time you are adding or modifying anything to it.



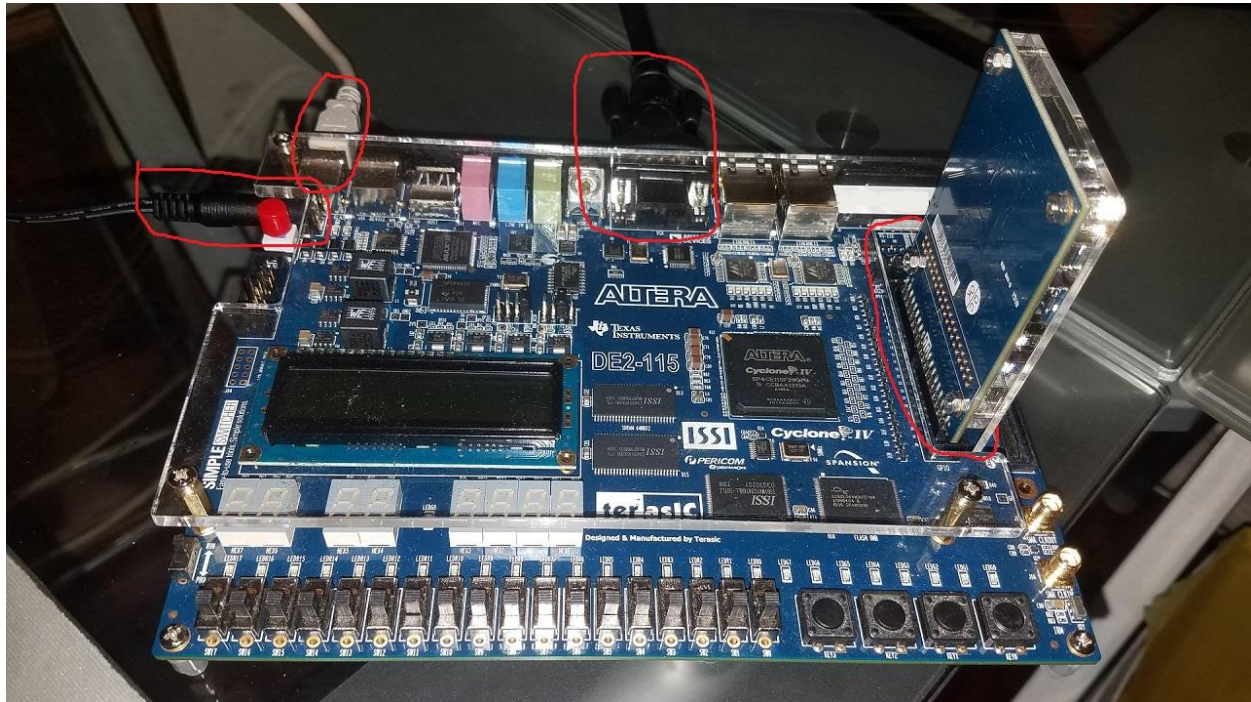
Before we do any modifications to the DE2_115_CAMERA folder, you must test this project to make sure that it works by programming the project onto the DE2-115 board.

Note: This folder already contains the programming files, so you do not need to compile it right now. But, we will do so after checking if the D5M camera works.

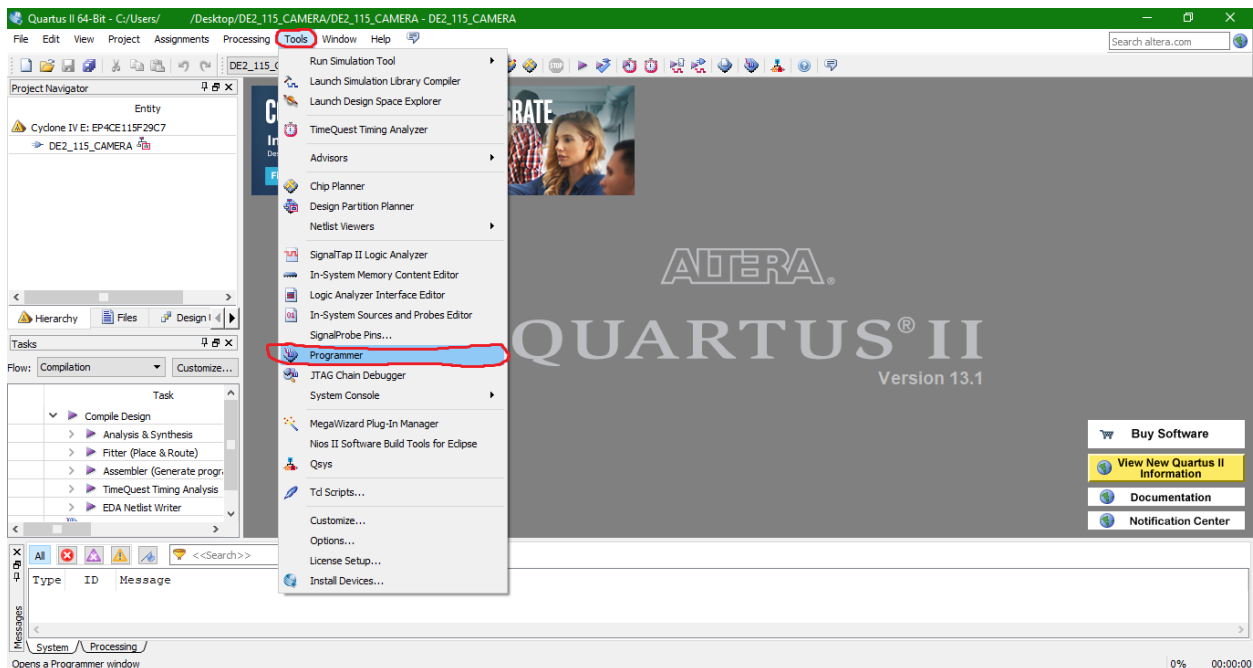
- Open the **DE2_115_CAMERA** folder (making sure that Quartus II 13.1 is already installed). Then, click on **DE2_115_CAMERA.qpf** (Quartus project file). Afterwards, Quartus II 13.1 will be launched.



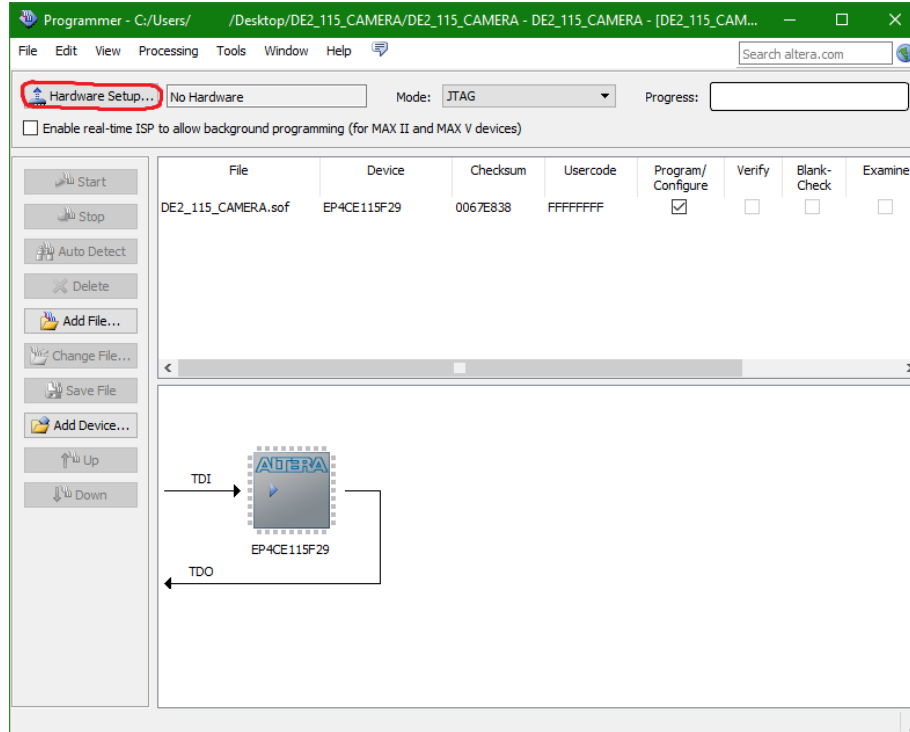
6. Before we proceed, make sure that you connect the DE2-115 to your computer using the provided USB cable (connect the other end to the BLASTER connection on the DE2-115). Also, connect the VGA cable from the VGA port on the DE2-115 board to the VGA port of your monitor, TV, etc. Don't forget to plug in the camera and power as well.



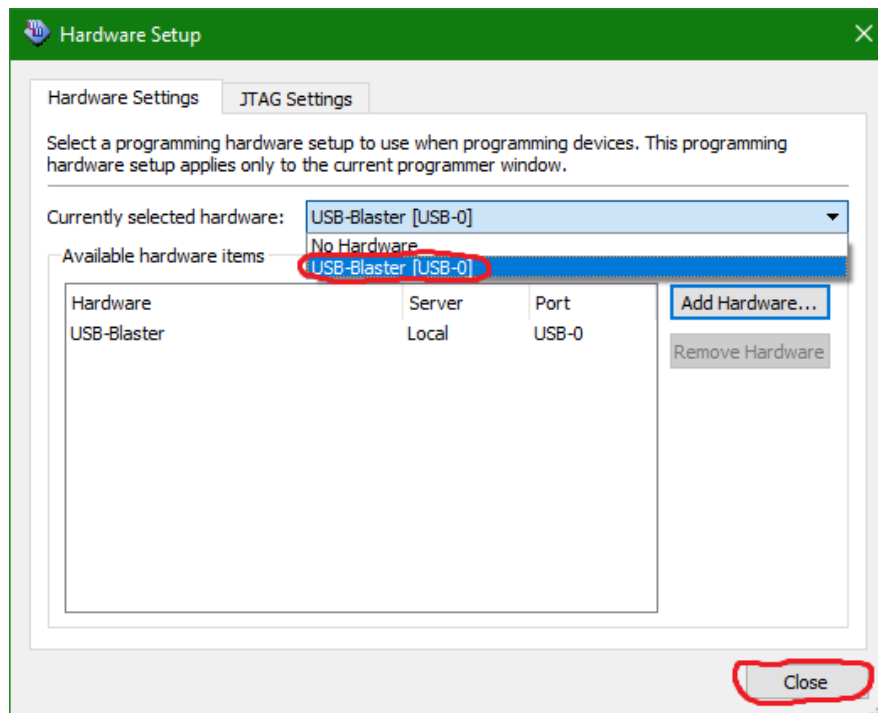
7. Back to the Quartus. Now, go to **Tools** → **Programmer**.



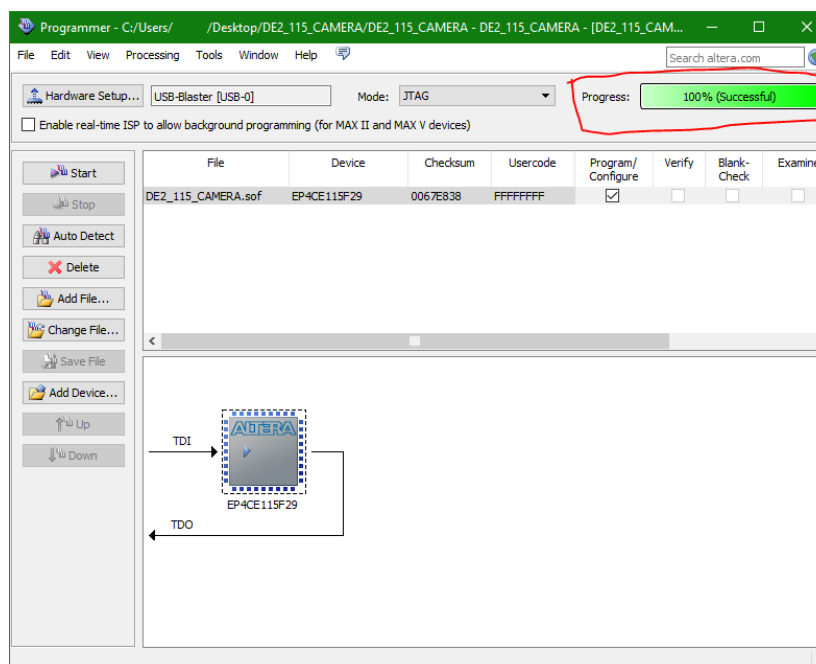
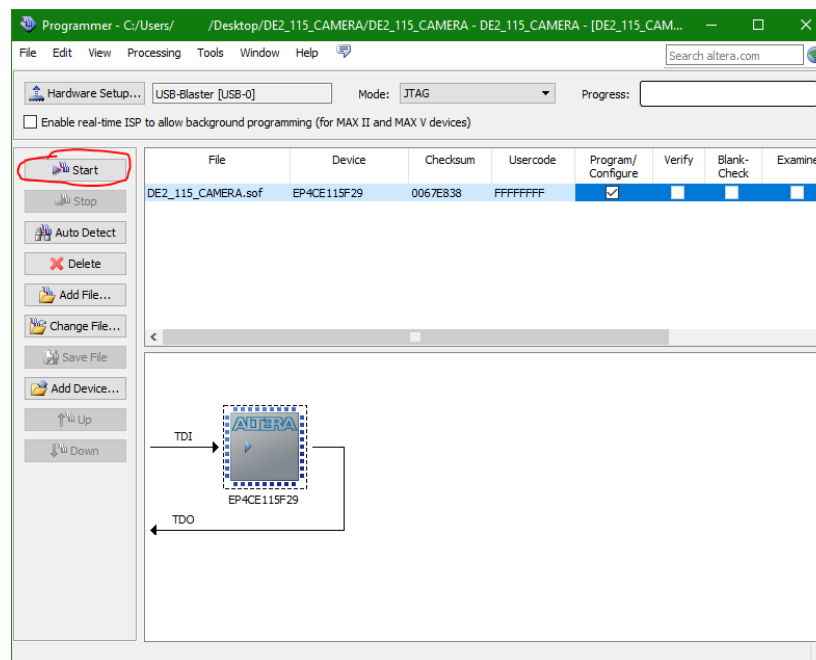
8. On the **Programmer** window, click on **Hardware Setup**.



9. At this point, make sure that the device drivers for the DE2-115 is installed in your computer. On the **Currently selected hardware** dropdown, select **USB-Blaster [USB-0]** (the number may vary depending on if you have multiple boards connected). After, press **Close**.



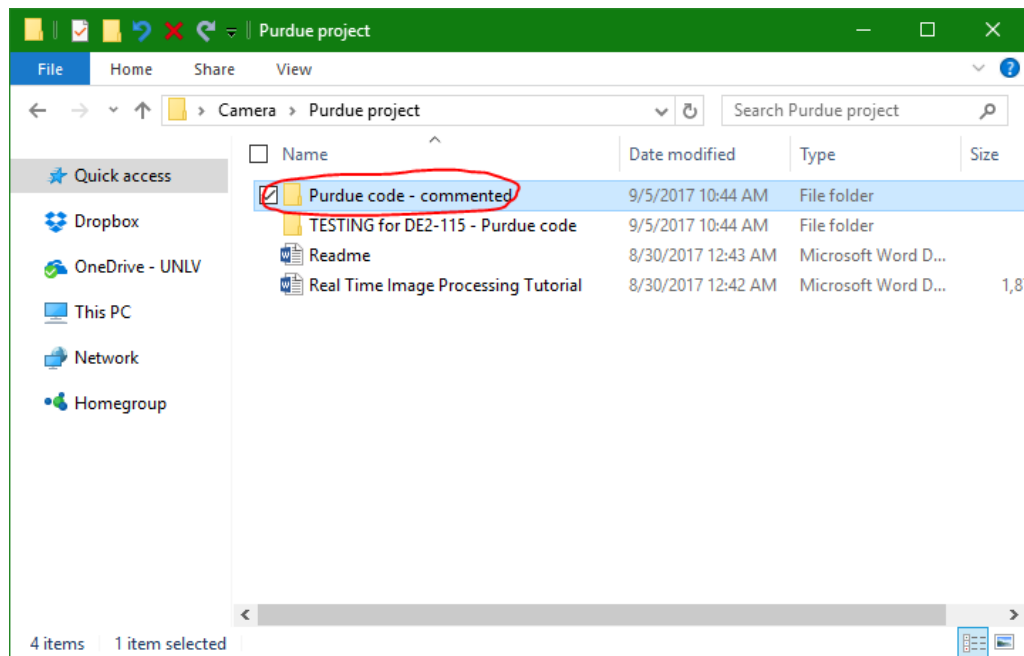
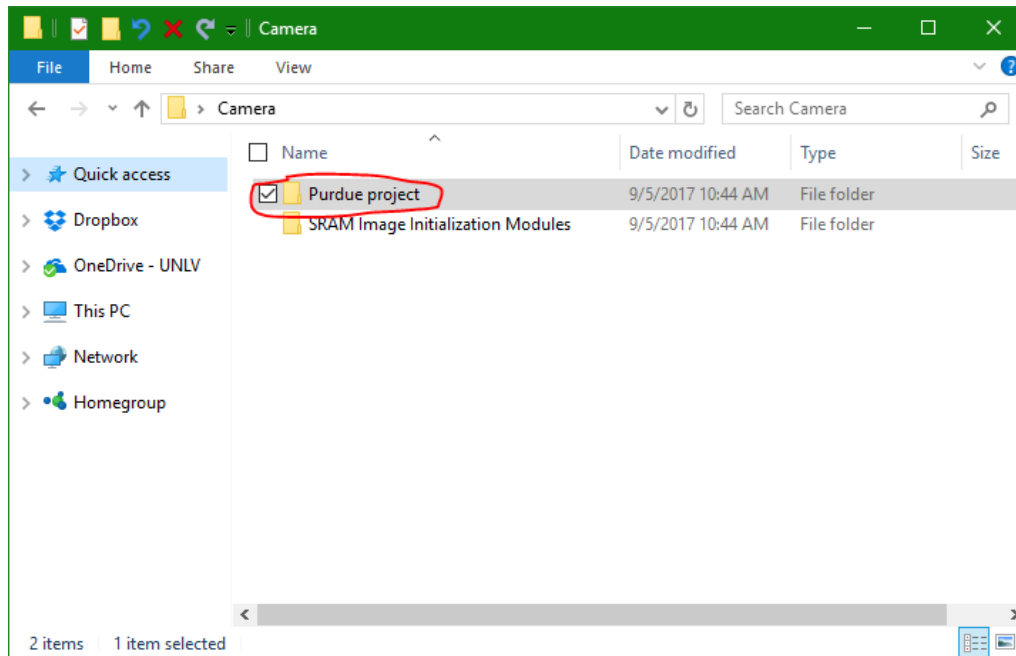
10. We're almost done! At the **Programmer** window, press **Start**. The program will be loaded onto the DE2-115 board. You will know that you have successfully done in when it says **100% (Successful)** on the progress bar. The camera's video feed will show in your monitor.

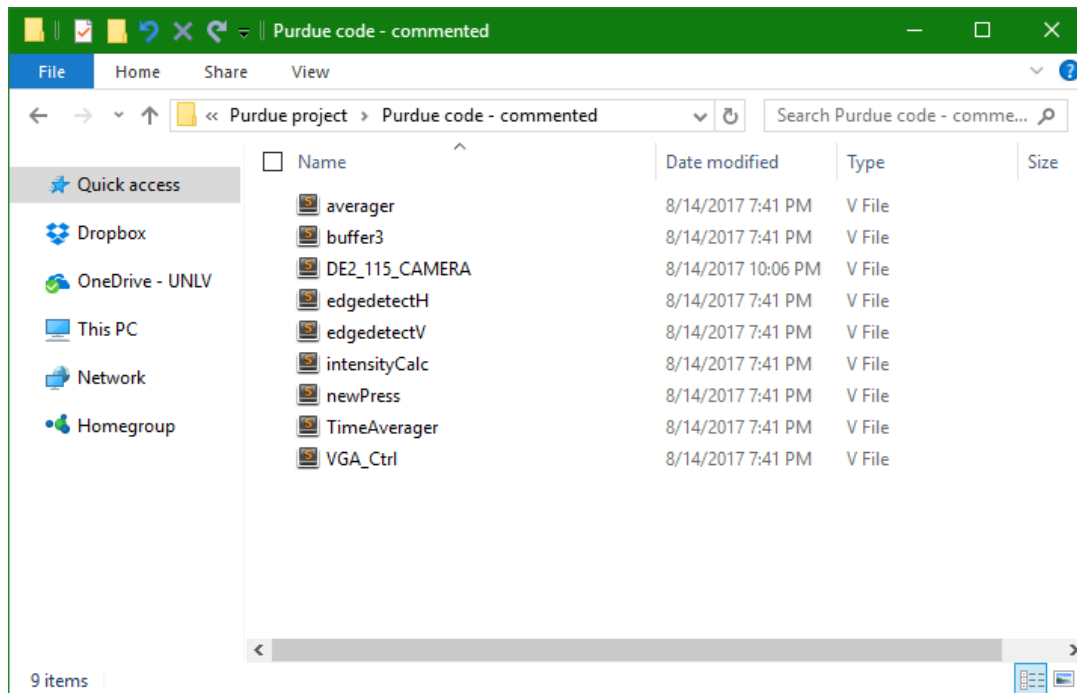


That concludes the initial setup for the D5M camera. The next part of the tutorial deals with the loading the demo projects onto the DE2-115 board by modifying the original Terasic code. That is why it is necessary to make a copy of the original **DE2_115_CAMERA** folder to make any changes to it, so that you can preserve the original code if something goes wrong in yours.

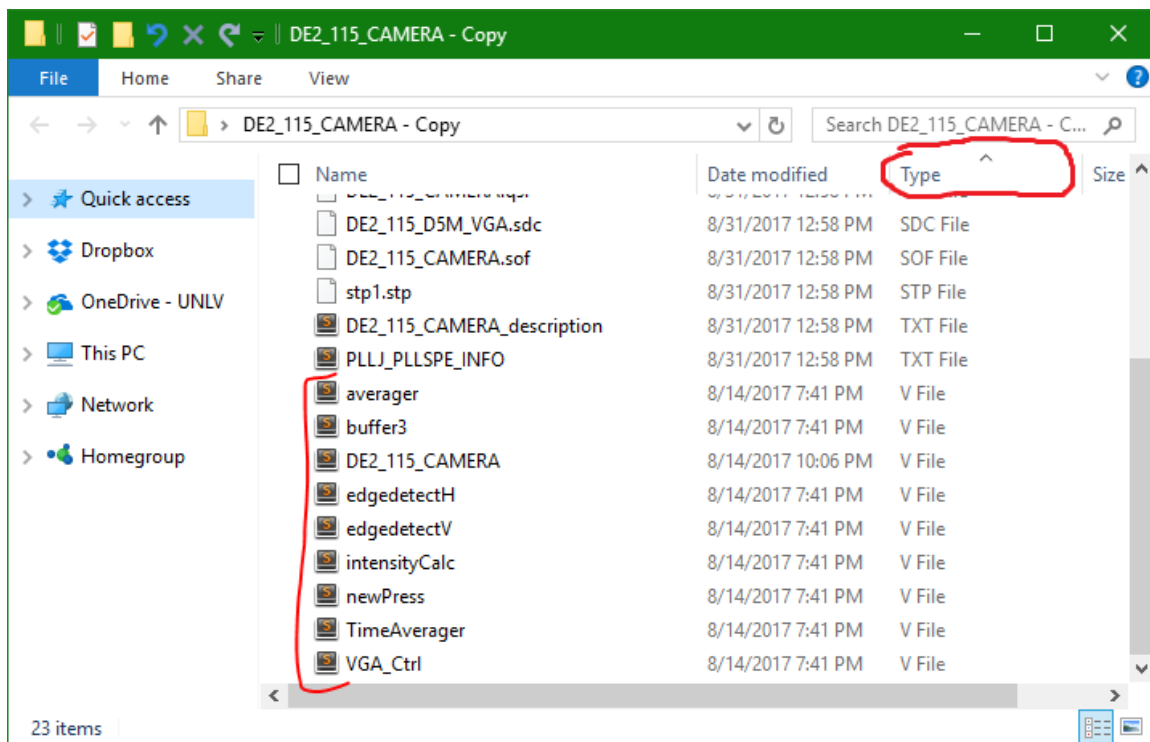
Tutorial Part 2: Loading Demo Projects

1. Now that you've successfully setup the camera, we will now load the demo projects from the **CPE 409-609** folder onto the DE2-115. After you made a copy of the **DE2_115_CAMERA** folder, open the **Camera** folder. Go to **Purdue project** → **Purdue code - commented**. This directory should have a couple of Verilog files in it.



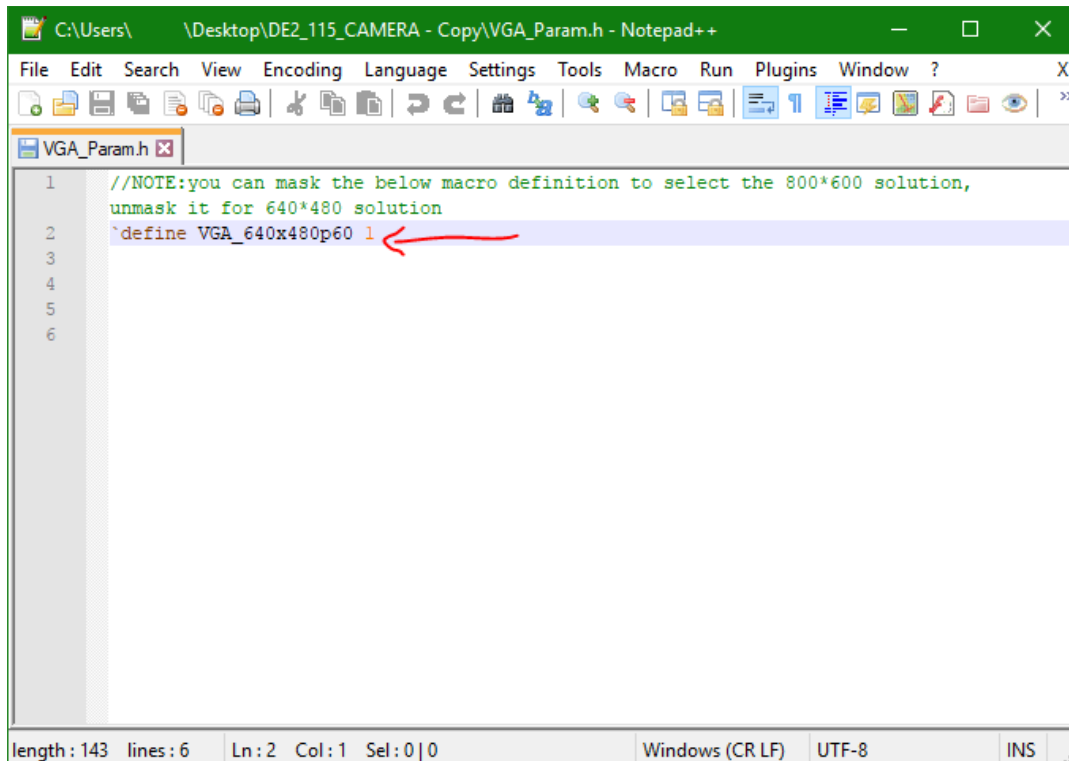
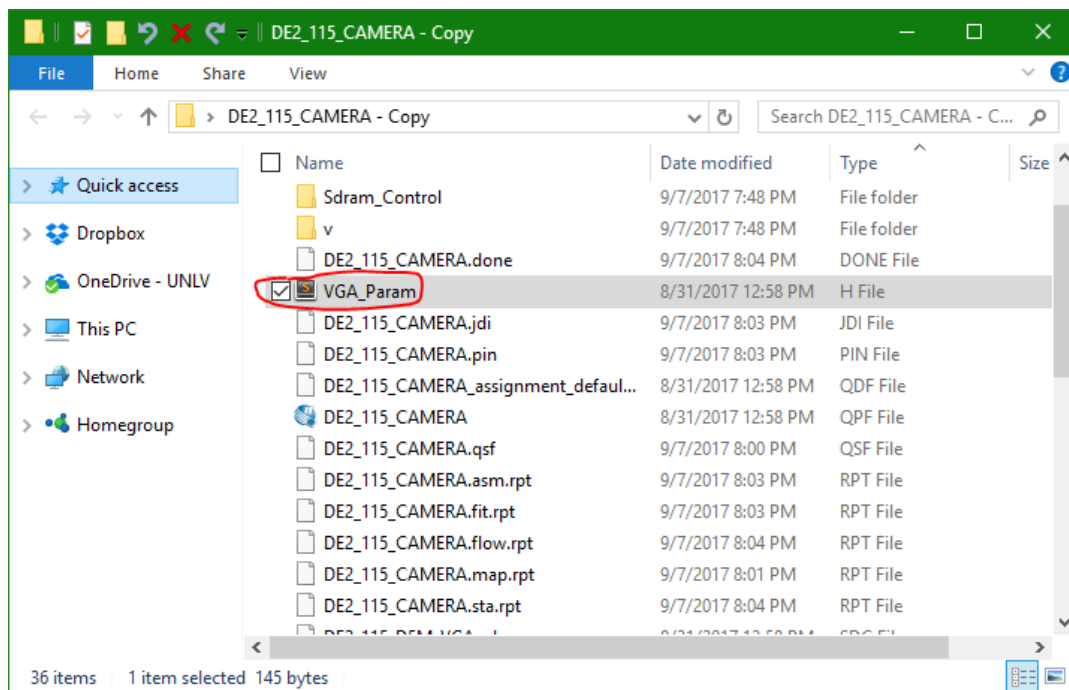


- Copy these files and paste them into a copy of the **DE2_115_CAMERA** folder. When it asks you to overwrite the **DE2_115_CAMERA.v** file, you **MUST** click **YES**. Otherwise, this will NOT work!

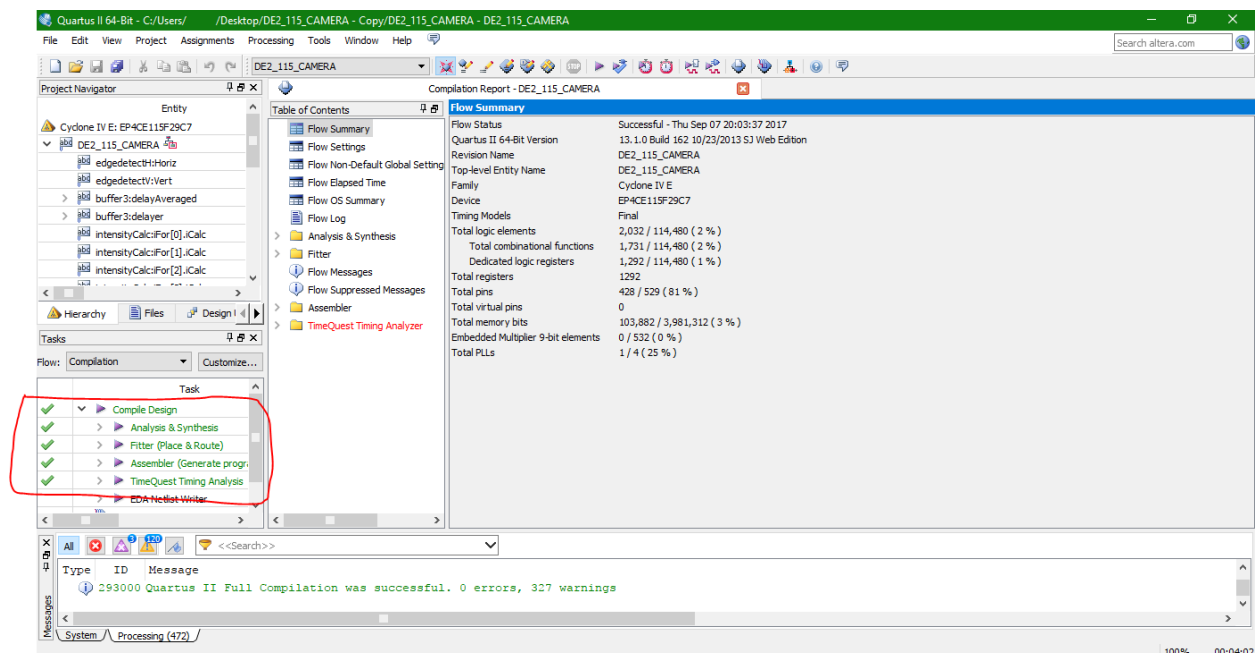
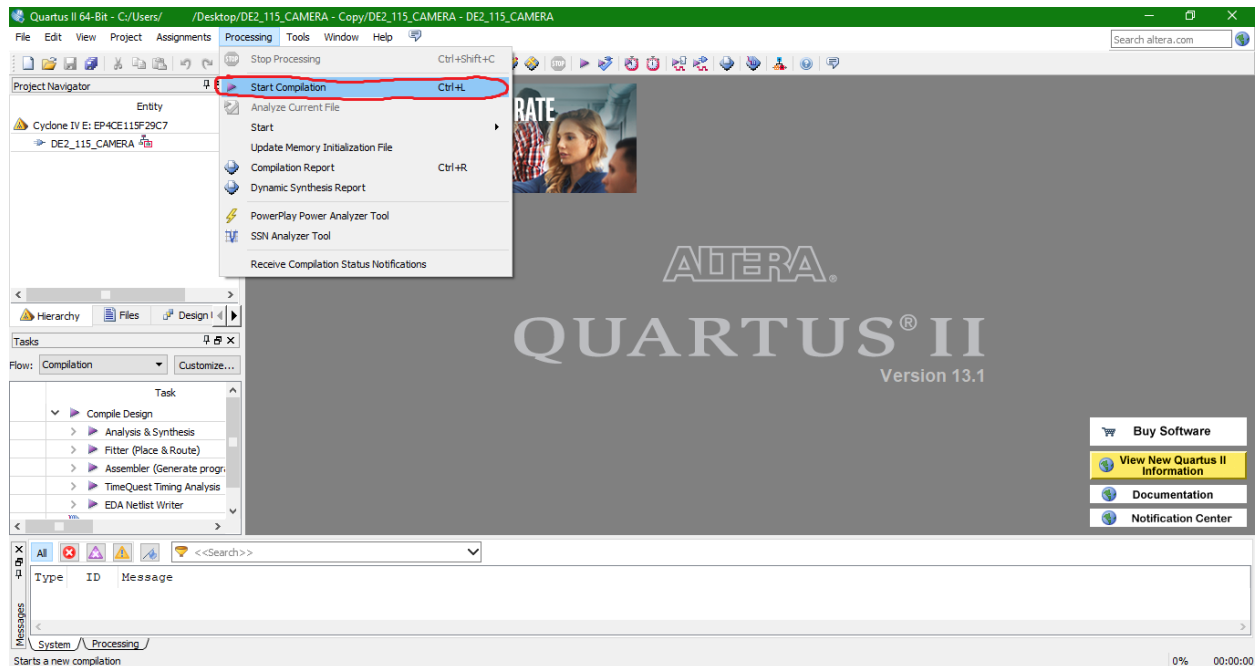


Optional: To see all the Verilog files in one place like above, click on **Type**.

- Before opening Quartus, open **VGA_Param.h** file in any text editor of your choosing. Uncomment the define statement. Save this file after making this change. This modification will ensure that the VGA display will be 640x480.



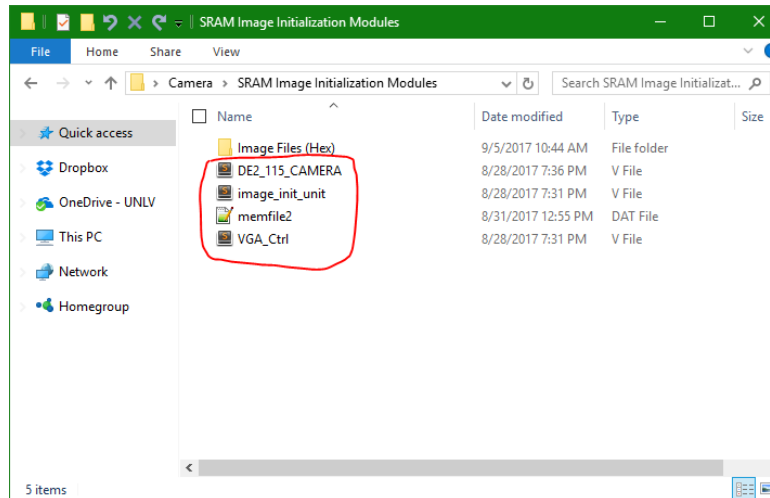
4. Open the **DE2_115_CAMERA.qpf** (Quartus project file) on the same directory. Once Quartus II opens, click on **Processing** → **Start Compilation**. Alternatively, you can press the key binding **Ctrl + L** to perform the previous task. It will compile Purdue's demo project for the DE2-115 board. The compilation process is over when you see all green checks.



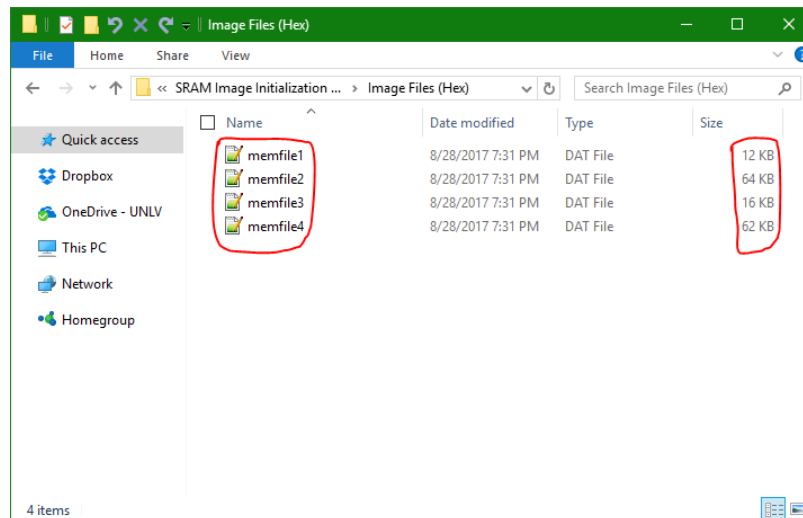
5. In terms of the hard part, you are done! Just repeat steps 7-10 of the first part of this tutorial to program this onto the DE2-115 board. For more details about the various image processing modules, just click on the Verilog modules on that directory. Also, you can refer to **Real Time Image Processing Tutorial** document in **Purdue project** folder.

Running the SRAM initialization demo project

To run the other demo project, make a new copy of the DE2_115_CAMERA original folder. Then, copy all four files from the **SRAM Image Initialization Modules** folder (excluding the **Image Files (Hex)** folder) onto the newly created folder. Remember, you must overwrite the **DE2_115_CAMERA.v** file. Afterwards, open the DE2_115_CAMERA.qpf file to open Quartus II. From there, repeat steps 3-5 of the second part of this tutorial. You **MUST** include the **memfile2.dat** file to make these modules work.

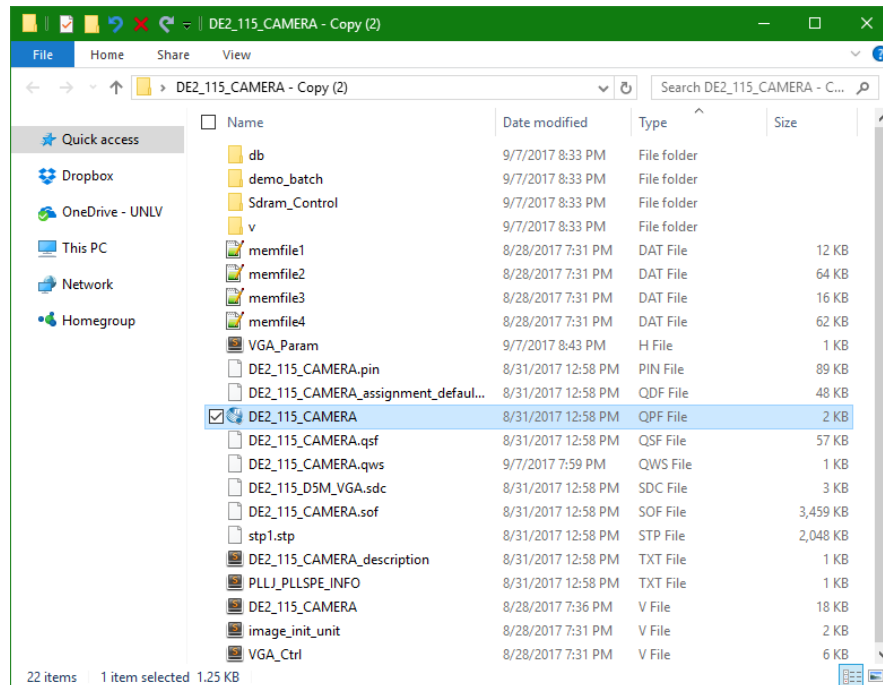


You should now see the picture of Lena in a 128x128 window. You can change the image shown in the screen by first copying the contents of **Image Files (Hex)** onto the same **DE2_115_CAMERA** folder where you placed the SRAM initialization modules. When it asks you to overwrite **memfile2.dat**, you can choose either option (since they are the same file).



Notice how these files have different sizes, the 12KB and 16KB files contain 64x64 images (**memfile1.dat** & **memfile3.dat**). The other ones are 128x128 images (**memfile2.dat** & **memfile4.dat**).

This is what your directory may look like:



To change to any of the other images, open **image_init_unit.v** file. Edit this part of the code:

```
40 // Structural coding
41 //=====
42
43 // Memory Initialization Code - change the file name & size parameters for
44 // different images
45 initial $readmemh ("memfile2.dat", mem);
46 parameter WIDTH = 128;
47 parameter HEIGHT = 128;
48
49 // CODE - Read & Write
50 always @ (posedge rClk) begin
51     if(re) begin
52         if(iY >= 0 && iY < HEIGHT && iX >= 0 && iX < WIDTH)
53             rd <= mem[iX * WIDTH + iY];
54         else
55             rd <= 0;
56     end
57 end
58 endmodule
59
```

With the dimensions mentioned earlier, you simply change the file name on the initial statement into the other **memfileX.dat** files and edit the parameters to the corresponding sizes. After saving your changes, you can now compile the project and see the changes on your monitor.