Galileo & DE2i-150 Interface: Photocell Circuit

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EECE494: Computer Bus and SoC Interfacing

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Idea Formation

Simulation of a monitoring device that shows the state of photocell as low or high.

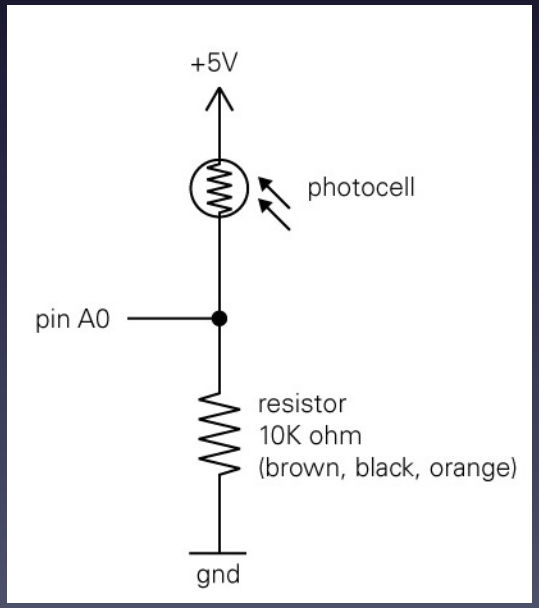
Accomplished through interface of Galileo board & DE2i-150 board, using GPIO expansion of DE2i-150 board.

Introduction

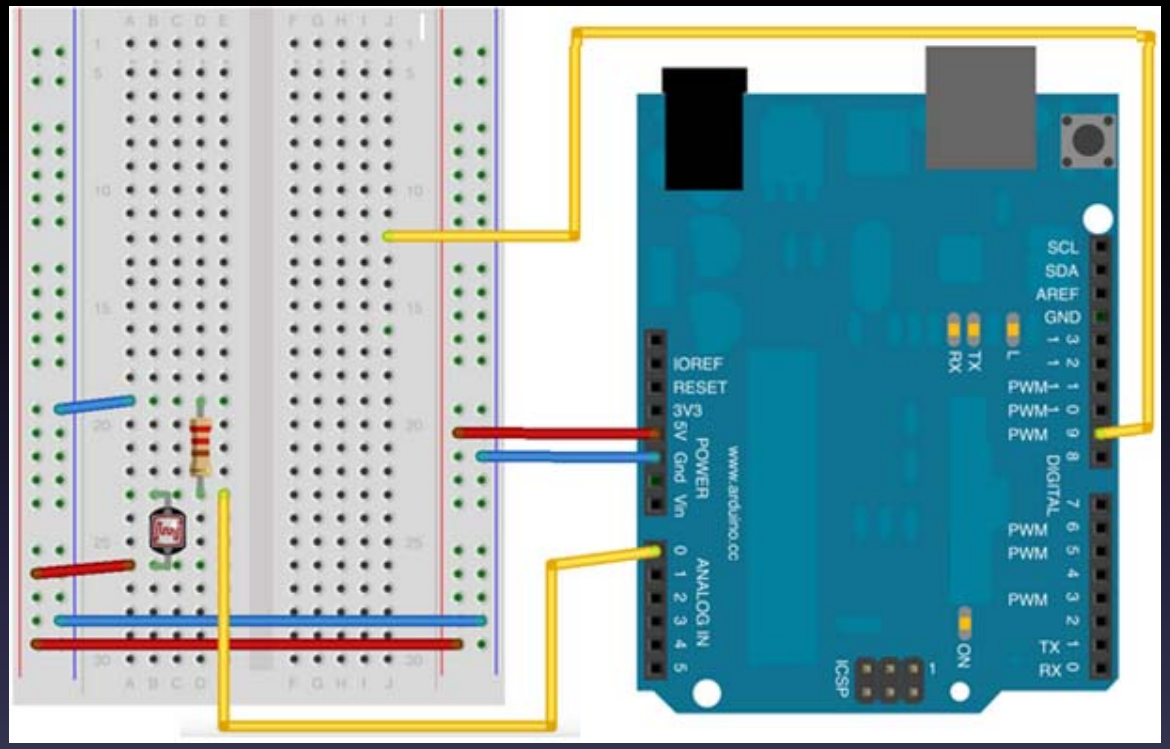
- A message, determined by the Galileo board, will appear on the DE2i-150, notifying the user if a photocell is detecting light or not.
- The photocell is detecting light if the message reads High.
- The photocell is not detecting light if the message reads Low.

Principle

- **Photocell:** A light-controlled variable resistor. Its resistance decreases with increasing incident light intensity.



Setup & Materials



Materials:

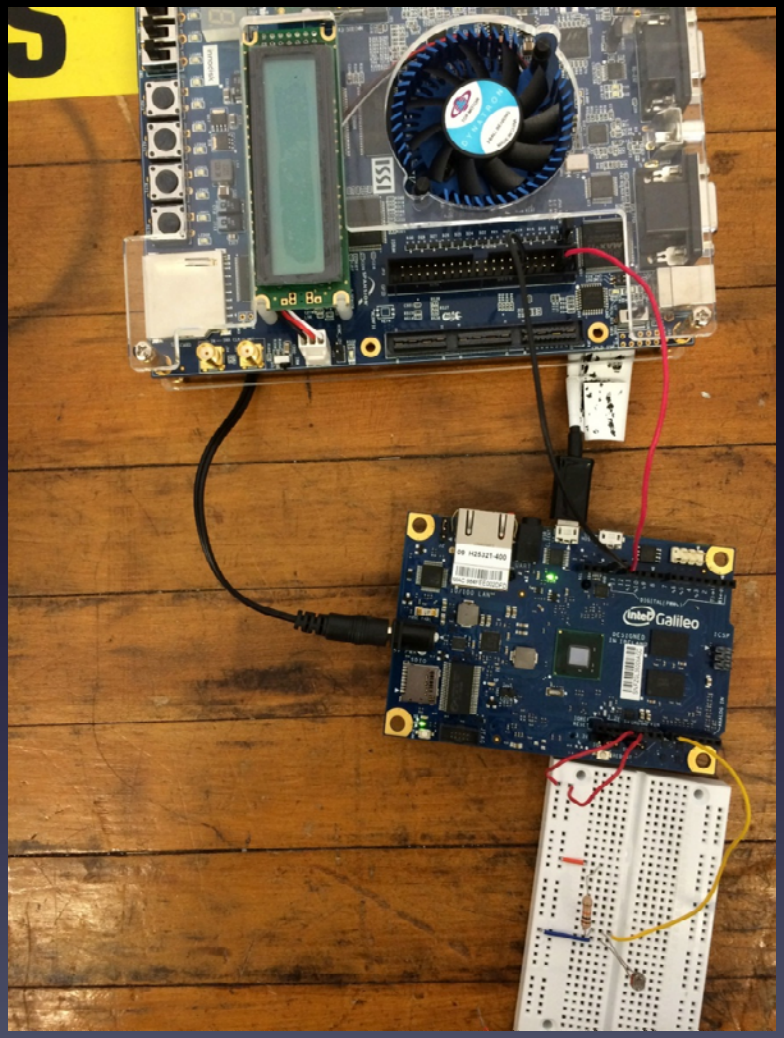
- 1 Galileo board
- 1 Photocell
- 1 Resistor
  - 10 kΩ
- Wires
- 1 DE2i-150 board

Setup:

- Connect GPIO to pin 13 (PWM) of Galileo board
- Connect of photocell to pin AO (analog input) of Galileo board

Step 1 – Set Up Circuit

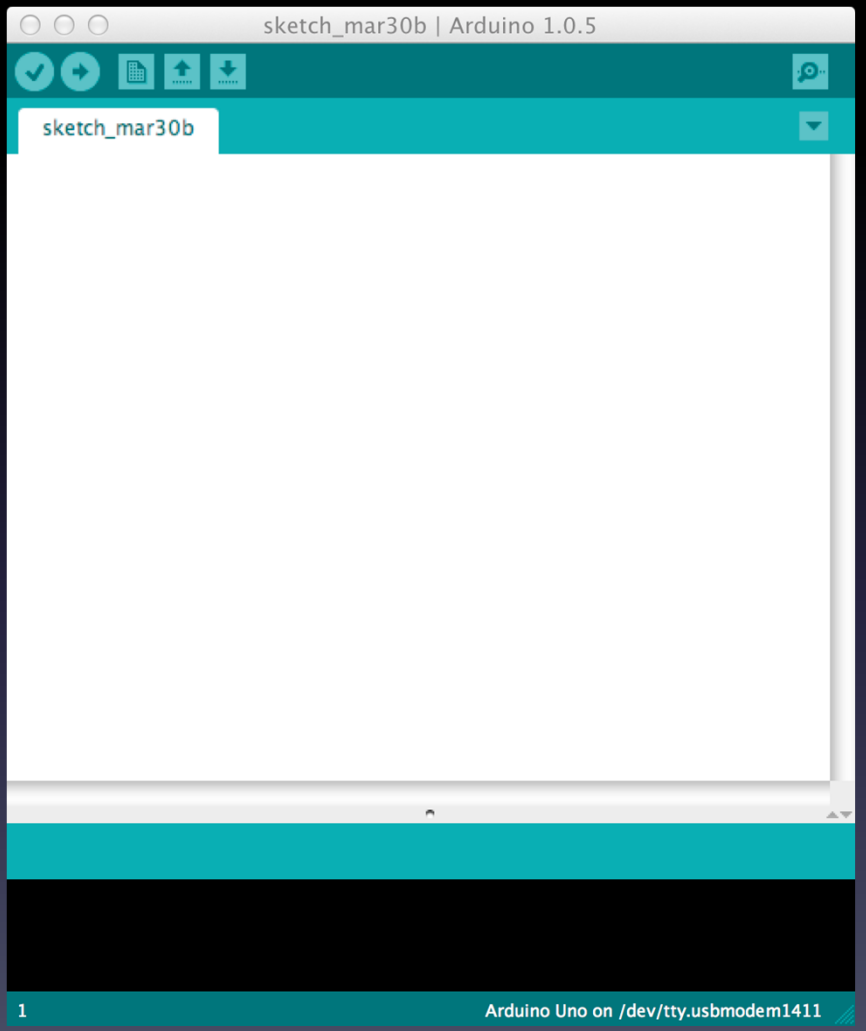
- One pin of the photocell is connected to both GND, through a resistor, and the analog input pin, AO.



Step 2 – Open New Galileo Sketch

- Verify: To check for errors in the code

- Upload: To send code to Galileo board



Step 3 – Pin Assignments

```
int photoPin = A0;  // The photocell is connected to pin A0
int gpioPin = 13;    // The GPIO is connected to pin 13
int photoValue;     // The analog reading from the photocell
```

- The photocell acts as an analog input to the Galileo board, and is therefore connected to the analog pin, A0.
- The GPIO acts as an digital output, and is therefore connected to the digital pin, 13.

Step 4 – Setup Routine

```
void setup() {

  pinMode(gpioPin, OUTPUT); // Initialize the digital pin as an output.

}
```

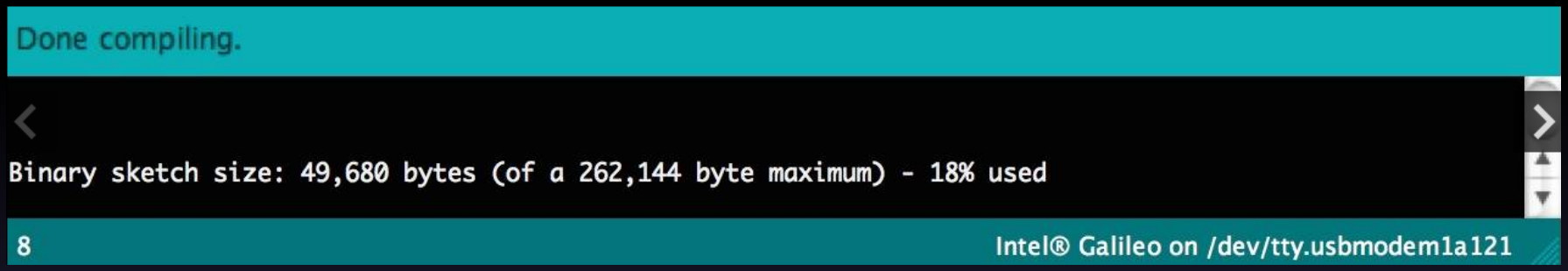
- pinMode():Configures the specified pin to behave either as an input or an output.
- GPIO will be a digital output.

Step 5 – Loop Routine

```
void loop() {
  // Read the analog in value:
  photoValue = analogRead(photoPin);

  if (photoValue < 500) {
    digitalWrite(gpioPin, LOW); // Send no signal to the GPIO expansion of the FPGA board
  }
  else {
    digitalWrite(gpioPin, HIGH); // Send a signal to the GPIO expansion of the FPGA board
  }

delay(10);
}
```

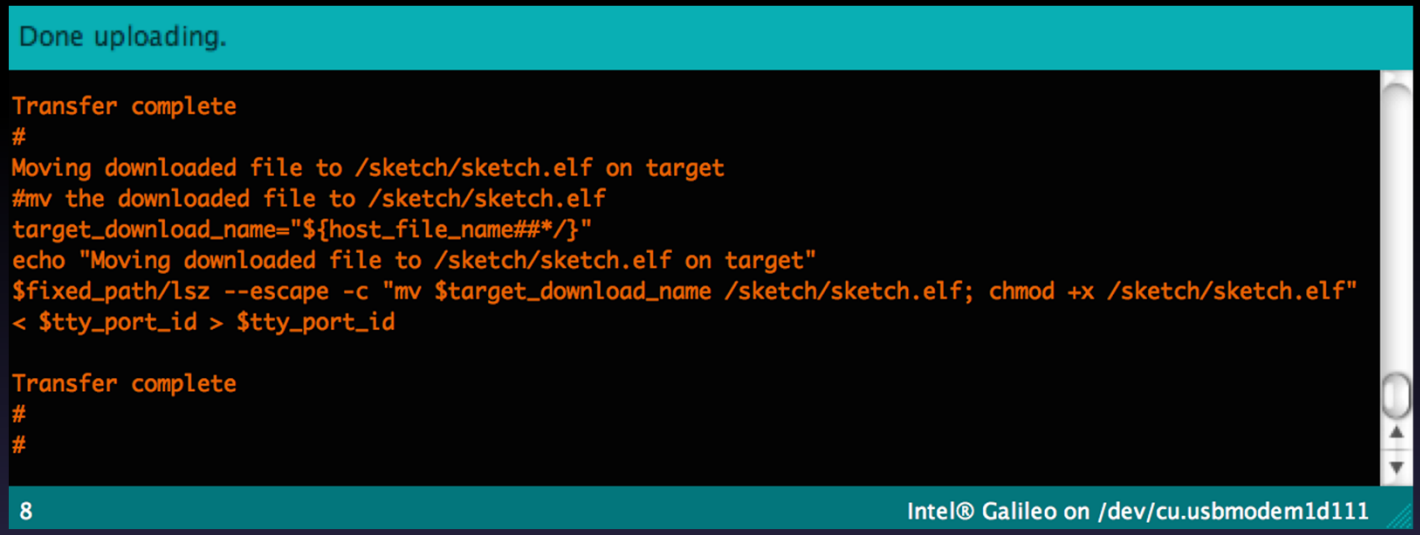
- analogRead(): Reads the value from the specified analog pin.
- digitalWrite(): Writes a HIGH or a LOW value to a digital pin. Output pin set to oV (ground) for LOW.
- delay(): Pauses the program for specified amount of time (milliseconds)

Step 6 – Verify Code



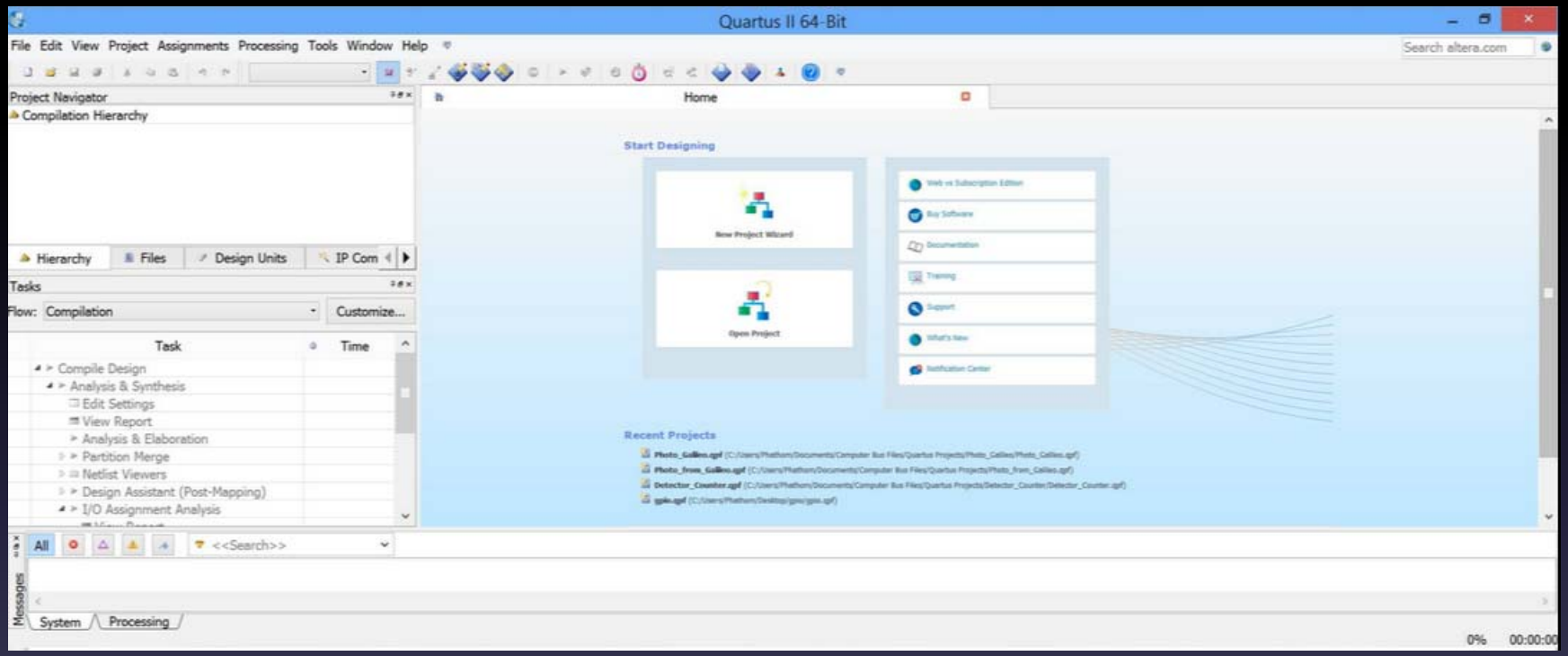
- Verify the code to check for errors
- Errors would be displayed at the bottom of the window

Step 7 – Upload to Galileo



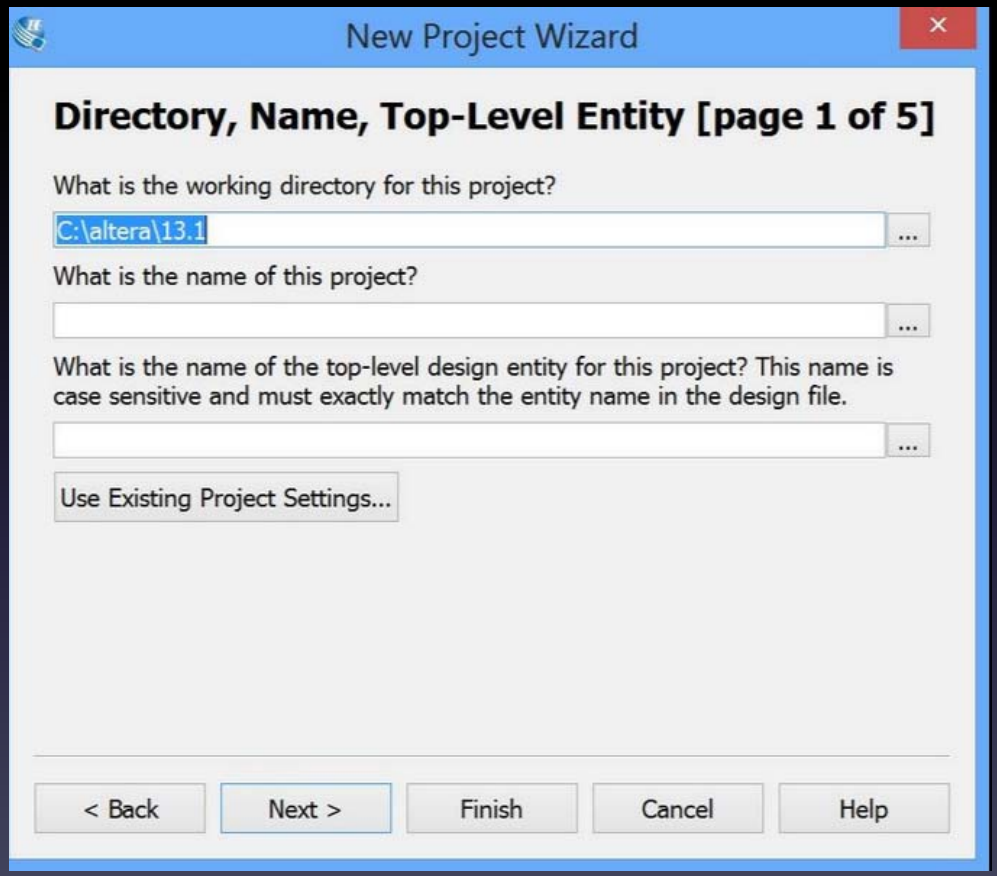
- Send code to Galileo board via USB
- If unknown, serial port can be found by:
  - Tools -> Serial Ports -> /dev/tty.usbmodel1411

Step 8 – Quartus II Home Page



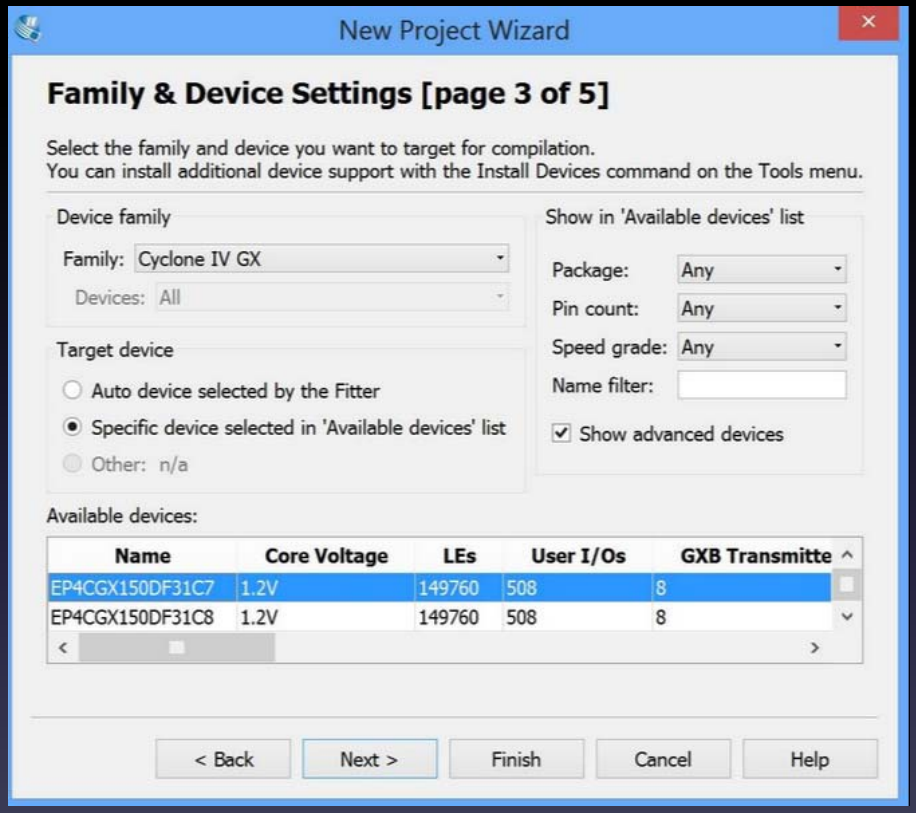
- Select File -> New Project Wizard
- Click Next

Step 9 - Directory



- Enter information about your project
  - Working Directory
  - Name of New Project
- Click Next

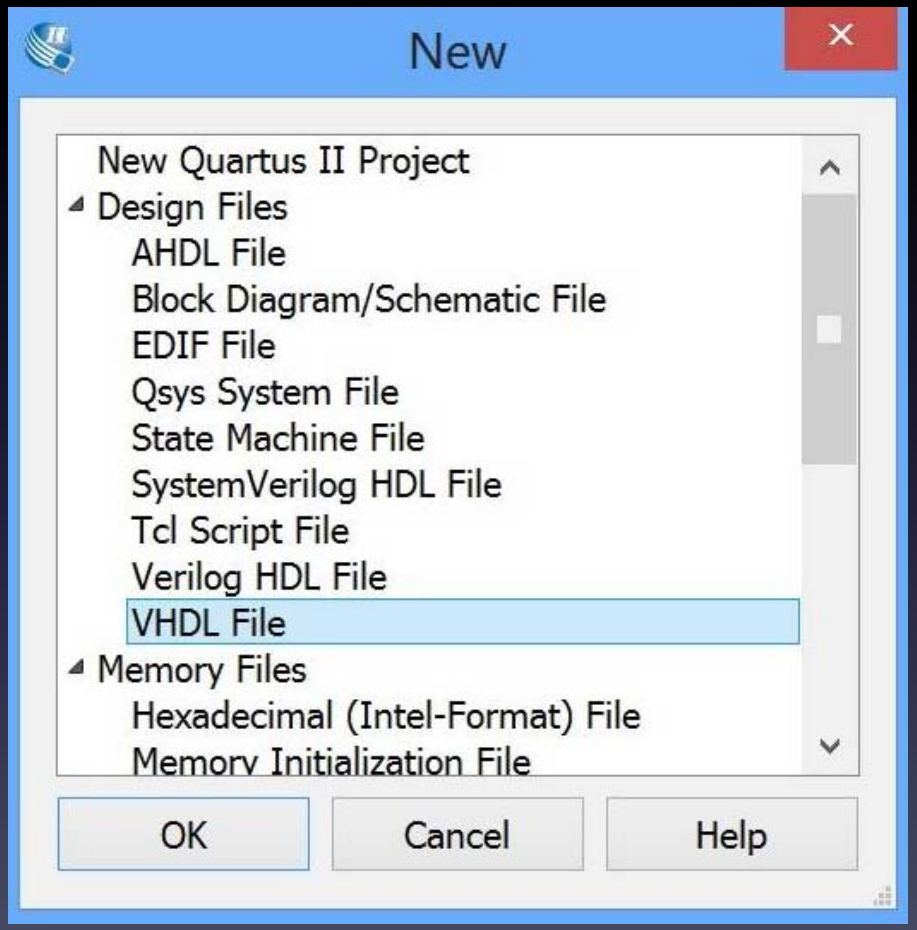
Step 10 – Device Settings



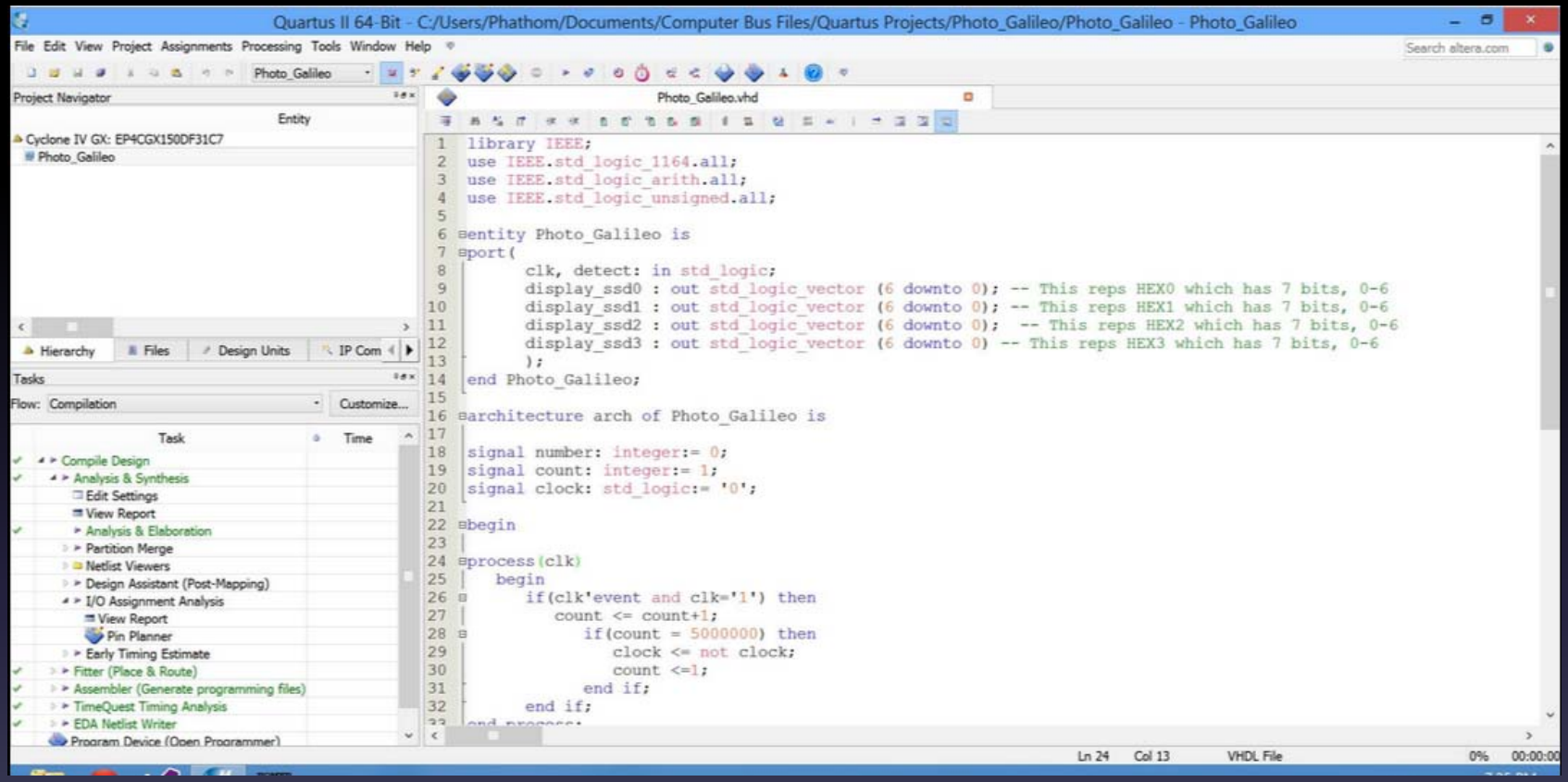
- Assign a Specific FPGA to design and make Pin Assignments
  - Click Finish
  - Click Yes to create project directory

Step 11 – New VHDL File

- Select File -> New -> VHDL File
- Click OK.



Step 12 – Write VHDL Code



- Type VHDL code into Blank Project Space

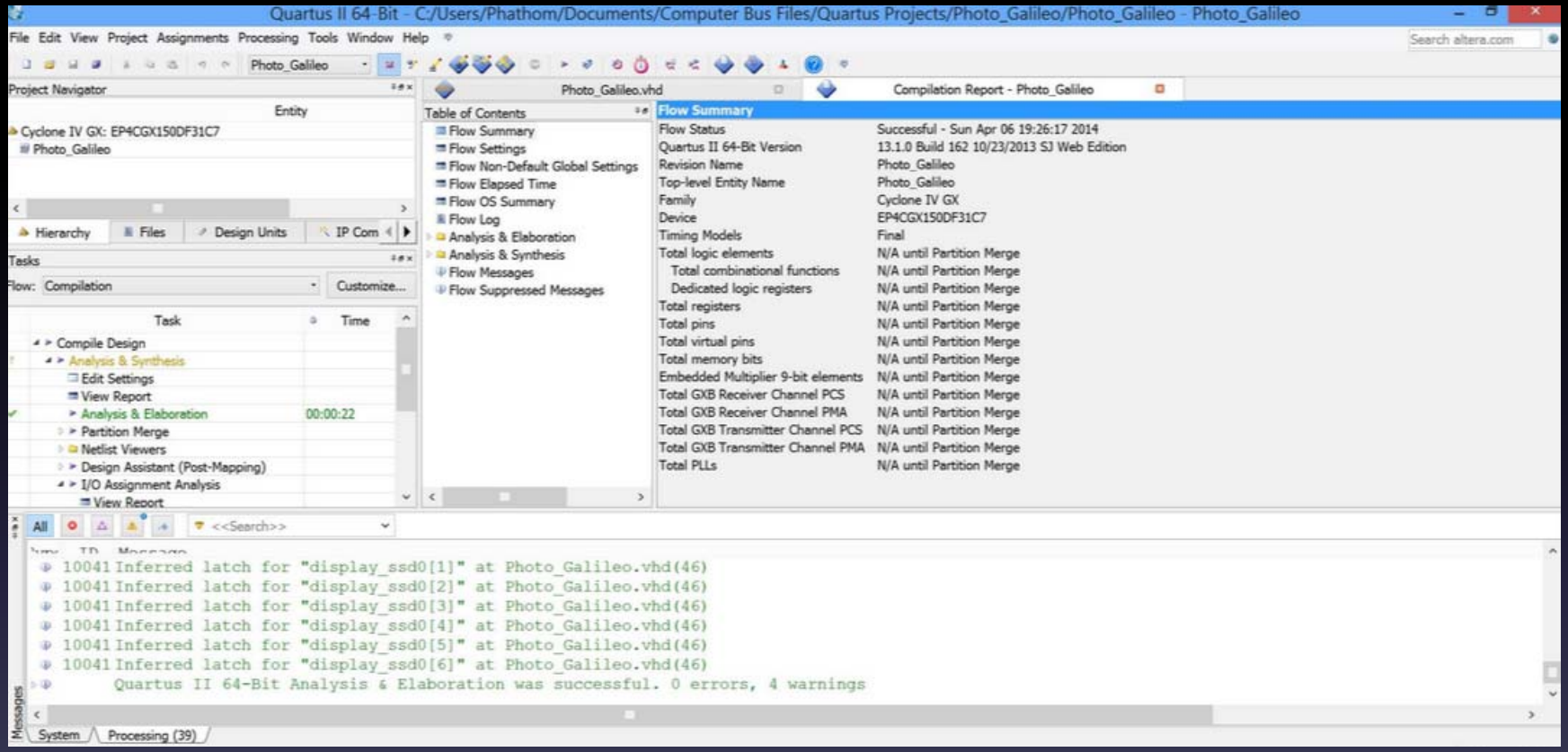
Step 12 – Write VHDL Code

```
library IEEE;
use IEEE.std_logic_1164.all;
use IEEE.std_logic_arith.all;
use IEEE.std_logic_unsigned.all;

entity Photo_Galileo is
port(
		clk, detect: in std_logic;
		display_ssd0 : out std_logic_vector (6 downto 0); -- This reps HEX0 which has 7 bits, 0-6
		display_ssd1 : out std_logic_vector (6 downto 0); -- This reps HEX1 which has 7 bits, 0-6
		display_ssd2 : out std_logic_vector (6 downto 0);  -- This reps HEX2 which has 7 bits, 0-6
		display_ssd3 : out std_logic_vector (6 downto 0) -- This reps HEX3 which has 7 bits, 0-6
		);
end Photo_Galileo;

architecture arch of Photo_Galileo is

signal number: integer:= 0;
signal count: integer:= 1;
signal clock: std_logic:= '0';

begin

process(clk)
	begin
		if(clk'event and clk='1') then
			count <= count+1;
				if(count = 5000000) then
					clock <= not clock;
					count <=1;
				end if;
		end if;
end process;
```

Step 12 – Write VHDL Code

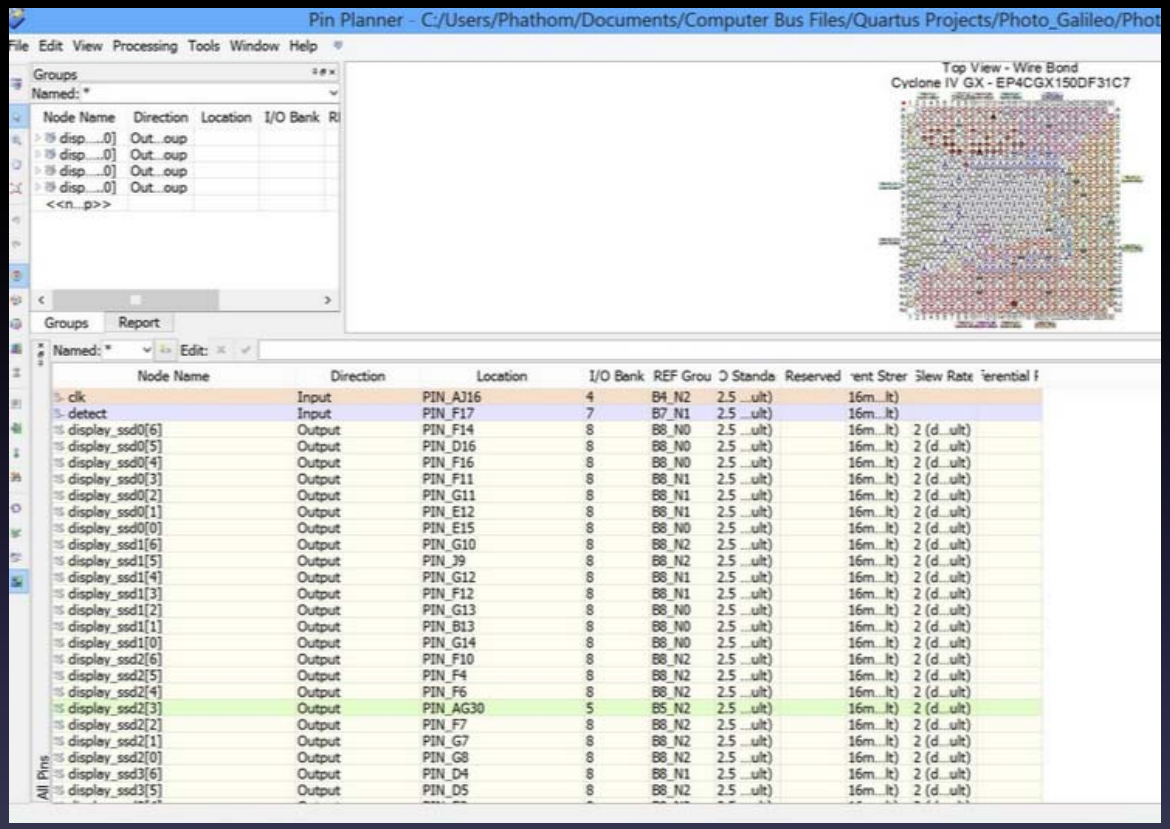
```
process (clock)
        begin
                if (clock'event and clock='1') then
                        if (detect = '1') then
                                number <= 1;
                        elsif (detect = '0')then
                                number <= 0;
                        end if;
                end if;
end process;

process(number)
        begin

                        if (number = 0) then
                                display_ssd0 <= "1000000";
                                display_ssd1 <= "1000111";
                                display_ssd2 <= "1111111";
                                display_ssd3 <= "1111111";

                        elsif (number = 1) then
                                display_ssd0 <= "1111001";
                                display_ssd1 <= "0001001";
                                display_ssd2 <= "1111111";
                                display_ssd3 <= "1111111";

                        end if;
end process;

end arch;
```

Step 13 – Analysis & Elaboration



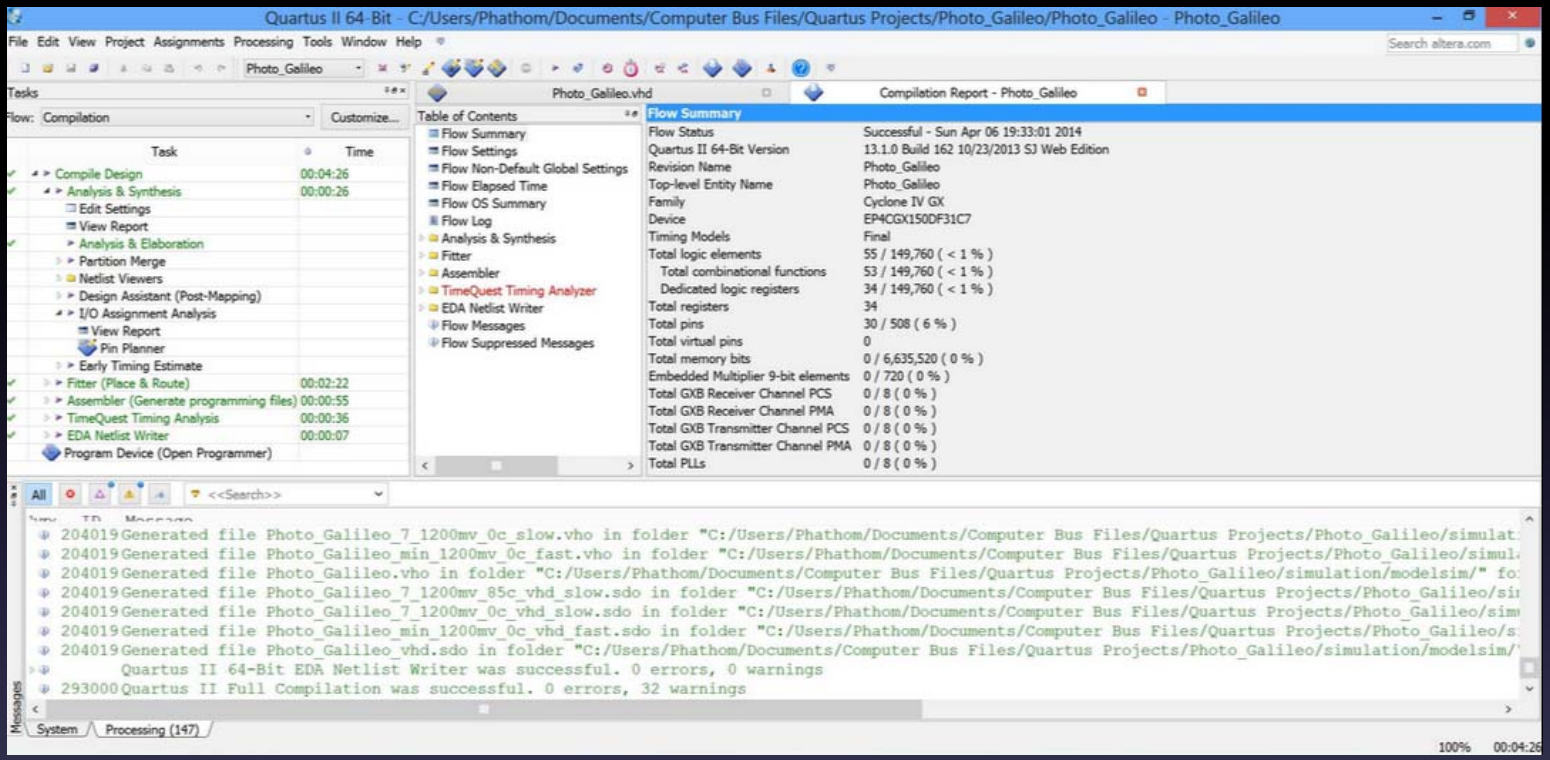
- Select Process -> Start -> Start Analysis & Elaboration
- Click OK.

Step 14 – Pin Planner



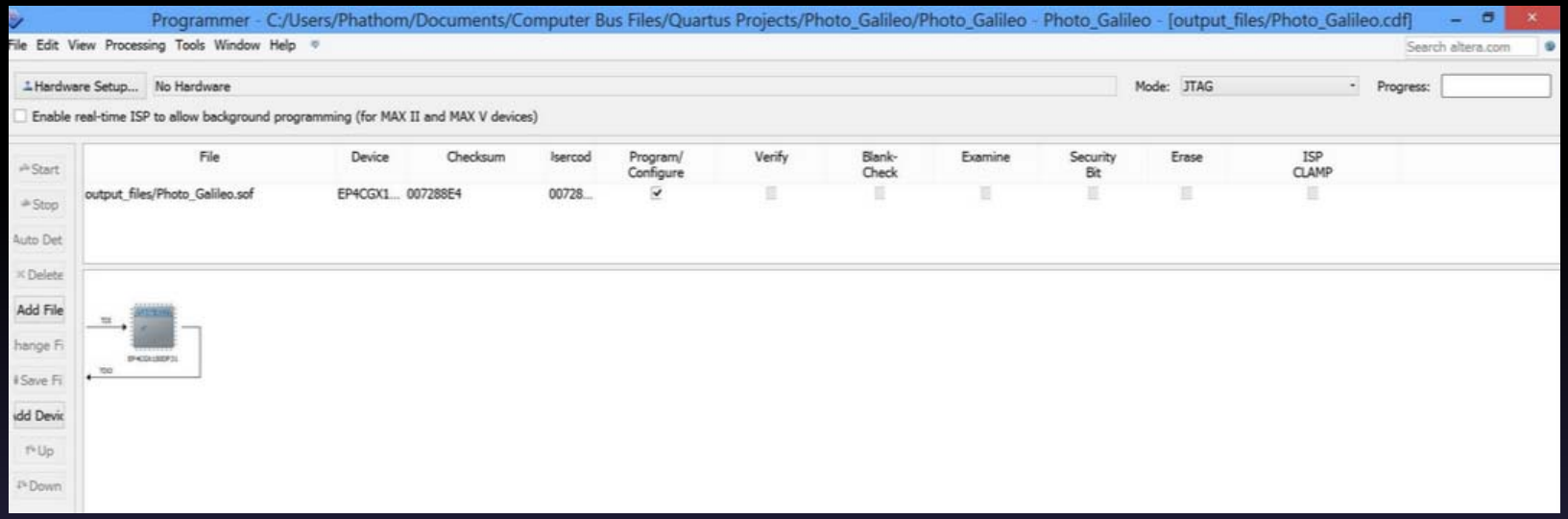
- Select Assignments -> Pin Planner
- In location Column add the pin numbers for values of DE2i-150 board
- The pin assignments can be found in the DE2i-150 FPGA System Manual

Step 15 – Start Compilation



- Select Processing Menu -> Start Compilation or Click Play button
- View Compilation Message & Report.
- Click OK.

Step 17 - Programmer



- Connect Power supply cable to board and power outlet, Connect USB-Blaster to J9 , USB cable to USB-Blaster , Connect other end of USB cable to host computer
- Turn on DE2i-150 board
- Select Tools -> Programmer
- Click Hardware Setup
- Select Project file from Directory
- Press Start

Conclusion

- Very fun and easy project.
- Can be modified for more features.
- Unsure if analog values can be displayed on 7-segment display.

References

- http://arduino.cc/en/Reference/analogRead
- http://arduino.cc/en/Reference/digitalWrite
- http://arduino.cc/en/Reference/delay
- http://arduinoarts.com/2011/08/tutorial-led-controlled-by-photo-sensor/
- http://learn.adafruit.com/photocells/using-a-photocell
- http://arduino.cc/en/Reference/pinMode