Galileo & DE2i-150 Interface: Photocell Circuit

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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 ightarrowphotocell 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, AO.
- 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);
}</pre>
```

- 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

Done uploading.

- 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

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Step 9 - Directory

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

Step 10 – Device Settings

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Available devices:

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EP4CGX150	DF31C8	1.2V		149760	508	8		~	
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- 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.

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Step 12 – Write VHDL Code

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• 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 \le count+1;
                              if(count = 5000000) then
                                     clock \leq not clock;
                                     count \leq 1:
                              end if:
               end if:
end process;
```

Step 12 – Write VHDL Code

process (clock)	
begin	
if (cle	ock'event and clock='1') then
	if $(detect = '1')$ then
	number <= 1:
	elsif (detect = '0')then
	$\operatorname{number} \leq -0$
	indificer <= 0,
	end if;
end i	i,
end process;	
process(number)	
begin	
	if $(number = 0)$ then
	display, sed $\alpha \leq = "1000000"$
	display_ssdo ≤ 1000000 ,
	$display_ssd1 \ll 1000111$,
	display_ssd2 <= "1111111";
	display_ssd3 <= "1111111";
	elsif (number = 1) then
	display ssd0 <= "1111001";
	display_ssd1 <= "0001001";
	display_ssd2 <= "1111111".
	$display_ssd3 <= "1111111"$
	display_5005 <= 1111111,
	and if
	ciiu ii,
end process;	
end arch;	

Step 13 – Analysis & Elaboration

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1	➤ Analysis &	Elaboration		00:0	0:22				Total GXB Receiver Char	nnel PMA	N/A until Partition Merge			
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- Select Process -> Start -> Start Analysis & Elaboration
- Click OK.

Step 14 – Pin Planner

Groups			2.6 ×					-	Top View - Wire	Bond
Named: *			~					5	clone IV GX - EP4CG	X150U
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3-ck			Input	PIN_AJ16	4	B4_N2	2.5ult)	16mit)		
- detect			Input	PIN_F17	7	B7_N1	2.5ult)	16mlt)		
3 display	_ssd0[6]		Output	PIN_F14	8	B8_N0	2.5ult)	16mlt)	2 (d_ult)	
3 display	_ssd0[5]		Output	PIN_D16	8	B8_N0	2.5 _ult)	16mlt)	2 (d_ult)	
is display	_ssd0[4]		Output	PIN_F16	8	B8_N0	2.5ult)	16mlt)	2 (d_ult)	
S display	_ssd0[3]		Output	PIN_F11	8	B8_N1	2.5ult)	16mlt)	2 (dult)	
is display	_ssd0[2]		Output	PIN_G11	8	B8_N1	2.5uit)	16mlt)	2 (d_ult)	
3 display	_ssd0[1]		Output	PIN_E12	8	68_N1	2.5ult)	16mlt)	2 (d_ult)	
S display	_ssd0[0]		Output	PIN_E15	8	68_N0	2.5ult)	16mlt)	2 (dult)	
S display	_ssd1[6]		Output	PIN_G10	8	68_N2	2.5uit)	16mlt)	2 (d_ult)	
S display	_ssd1[5]		Output	PIN_39	8	68_N2	2.5ult)	16mlt)	2 (dult)	
3 display	_ssd1[4]		Output	PIN_G12	8	68_N1	2.5ult)	16mlt)	2 (dult)	
-s display	_ssd1[3]		Output	PIN_F12	8	56_N1	2.5ult)	16mlt)	2 (dult)	
S display	_ssd1[2]		Output	PIN_G13	8	68_N0	2.5ult)	16mlt)	2 (d_ult)	
-s display	_ssd1[1]		Output	PIN_BIS	8	68_N0	2.5ult)	16mlt)	2 (dult)	
a display	ssd1[0]		Output	PIN_G14	8	58_N0	2.5 _ult)	16mlt)	2 (d_uit)	
a display	_ssd2[6]		Output	PIN_F10	8	58_N2	2.5ult)	16mlt)	2 (d_ult)	
-s display	_ssd2[5]		Output	PIN_F4	8	68_N2	2.5ult)	16mlt)	2 (duit)	
S display	_ssd2[4]		Output	PIN_P6	8	58_NZ	2.5ult)	16mlt)	2 (d_uit)	
-s display	_ssd2[3]		Output	PIN_AG30	5	65_N2	2.5uit)	16mlt)	2 (d_uit)	
S display	_ssd2[2]		Output	PIN_F/	8	68_N2	2.5ult)	16mlt)	2 (d_ult)	
-s display	_\$\$62[1]		Output	PIN_G/	8	58_N2	2.5 _ult)	16mlt)	2 (d_ult)	
2 display	_ssd2[0]		Output	PIN_G8	8	56_NZ	2.5 _ult)	16mlt)	2 (a_uit)	
a display	_ssd3[6]		Output	PIN_D4	8	56_N1	2.5ult)	16m. lt)	2 (d_ult)	
	\$\$0.5151		Output	PIN_D5	8	58 NZ	2.5ult)	16mlt)	2 (duit)	

- 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

Quartus II 64-Bit	C:/Users/Phathom/Documents	/Computer Bus Files/Quartu	s Projects/Photo_Galileo/Photo_G	Galileo - Photo_Galileo	- 5	×
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Tesks **	* 🔷 Photo_Galileo.vl	nd o 🧇	Compilation Report - Photo_Galileo	0		
low: Compilation • Customize	Table of Contents **	Flow Summary				
Task Time * > Compile Design 00:04:26 * > Analysis & Synthesis 00:00:26 * > Edit Settings * * > Analysis & Elaboration * * > Partition Merge * * > Partition Merge * * > Netlist Viewers * * > Lo Assignment Analysis * * > Vew Report * * > In Planner * * > Fitter (Place & Route) 00:02:22 * > Fitter (Place & Route) 00:02:55 * > Assembler (Generate programming files) 00:00:55 * > EDA Netlist Witter 00:00:06 * > EDA Netlist Witter 00:00:07 * Program Device (Open Programmer)	 Flow Summary Flow Settings Flow Non-Default Global Settings Flow Elapsed Time Flow Cog Analysis & Synthesis Fitter Assembler TimeQuest Timing Analyser Flow Messages Flow Suppressed Messages 	Flow Status Quartus II 64-Bit Version Revision Name Top-level Entity Name Family Device Timing Models Total logic elements Total orgic elements Total orgic elements Total registers Total registers Total versiters Total versiters Total versiters Total versiters Total versiters Total versiters Total Withpiler 9-bit elements Total GVB Receiver Channel PCS Total GVB Receiver Channel PCA Total GVB Transmitter Channel PCA Total GVB Transmitter Channel PCA	$\begin{split} & \text{Successful} - \text{Sun Apr 06 19:33:01 2014} \\ & \text{13.1.0 Build 162 10/23/2013 SJ Web Edition} \\ & \text{Photo_Galileo} \\ & \text{Photo_Galileo} \\ & \text{Cyclone IV GX} \\ & \text{Cyclone IV GX} \\ & \text{EP4CGX1S0DF31C7} \\ & \text{Final} \\ & \text{55} / 149,760 (< 1 \%) \\ & \text{53} / 149,760 (< 1 \%) \\ & \text{54} / 149,760 (< 1 \%) \\ & \text{54} \\ & \text{30} / 508 (6 \%) \\ & \text{0} \\ & \text{0} / 5,635,520 (0 \%) \\ & \text{0} / 8 (0 \%) \\ & \text{0} / 8 (0 \%) \\ & \text{0} / 8 (0 \%) \\ & \text{0} / 8 (0 \%) \\ & \text{0} / 8 (0 \%) \\ & \text{0} / 8 (0 \%) \\ & \text{0} / 8 (0 \%) \\ \end{array}$			
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- Select Processing Menu -> Start Compilation or Click Play button
- View Compilation Message & Report.
- Click OK.

Step 17 - Programmer

and a second											-	-
are Setup No Hardware									Mode: JTAG	•	Progress:	-
real-time ISP to allow background pr	ogramming (for MA	X II and MAX V device	es)									
File	Device	Checksum	Isercod	Program/ Configure	Verify	Blank- Check	Examine	Security Bit	Erase	ISP CLAMP		
output_files/Photo_Galileo.sof	EP4CGX1	007288E4	00728	3	1		1	1		1		
5%-C0130931												

- 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 7segment display.

References

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- http://arduino.cc/en/Reference/digitalWrite
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- http://arduinoarts.com/2011/08/tutorial-led-controlled-byphoto-sensor/
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- http://arduino.cc/en/Reference/pinMode