

# Digital design through Icoboard Lattice FPGA

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### 1 SOFTWARE SETUP

- 1) Boot the Raspberry PI from the SD card.
- 2) Open a console window and expand the root filesystem by typing the command below

```
sudo raspi-config
```

select the "Expand Filesystem" and reboot the Raspberry PI.

- 3) Open a console window and execute the following commands for installing wiringPi, IcoProg, IcoStorm tools, Arachne-pnr and Yosys.

```
cd $HOME
git clone git://git.drogon.net/
wiringPi
cd wiringPi && ./build

cd $HOME
sudo apt-get install subversion
svn co http://svn.clifford.at/
handicraft/2015/icoprogram
cd icoprogram && make install

sudo apt-get install build-
essential clang bison flex
libreadline-dev
sudo apt-get install gawk tcl-
dev libffi-dev git mercurial
graphviz
```

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```
sudo apt-get install xdot pkg-
config python python3
libftdi-dev
```

```
cd $HOME
git clone https://github.com/
cliffordwolf/icestorm.git
icestorm
cd icestorm && make && sudo
make install
```

```
cd $HOME
git clone https://github.com/
cseed/arachne-pnr.git
arachne-pnr
cd arachne-pnr && make && sudo
make install
```

```
cd $HOME
git clone https://github.com/
cliffordwolf/yosys.git yosys
cd yosys && make && sudo make
install
```

- 4) Open a text editor and type the following code. Save it as Makefile.

```
.PHONY: default
default: prog_sram

V_FNAME.blif: V_FNAME.v
yosys -p 'synth_ice40_-
blif_V_FNAME.blif'
V_FNAME.v

V_FNAME.asc: V_FNAME.blif
PCF_File.pcf
arachne-pnr -d 8k -p
PCF_File.pcf -o
V_FNAME.asc V_FNAME.
blif

V_FNAME.bin: V_FNAME.asc
```

```

        icetime -d hx8k -c 25
                V_FNAME.asc
        icепack V_FNAME.asc
                V_FNAME.bin

prog_sram: V_FNAME.bin
        icoprog -p < V_FNAME.
                bin

clean:
        rm V_FNAME.blif V_FNAME
                .asc V_FNAME.bin

```

## 2 EXAMPLE CODES

### 2.1 Blink LED

- 1) In the same directory, open a text editor and type the following verilog code and save it as Blink\_LED.v

```

module Blink_LED(input wire clk
, output reg A);
reg[26:0] delay;

always @(posedge clk) begin
delay = delay+1;
if(delay==27'
b1011111010111110000100000000
)
begin
delay_<=27'b0;
A<=(!A);
end

end
endmodule

```

- 2) In addition to the verilog file, we need to indicate to which FPGA pin we want to connect the A output.
- 3) This mapping is done in the file .pcf (pcf = Physical Constraint file).
- 4) Open a text editor and type the following and save it as Blink\_LED.pcf

```

set_io clk R9
set_io A B7

```

- 5) Now connect B7 pin of icoboard to positive end of LED.
- 6) Connect GND pin of icoboard to negative end of LED.

- 7) Now open the Makefile. Replace V\_FNAME with Blink\_LED, and PCF\_File with Blink\_LED.
- 8) Now open terminal and go to the Directory where all files are saved and type the following command.  
make
- 9) Now the LED, which is connected to icoboard starts blinking.

### 2.2 Decade Counter

- 1) Open a text editor and type the following verilog code and save it as decade\_counter.v

```

module decade_counter(
input wire clk,
output reg a, // a, b, c, d
, e, f, g are the final
outputs.
output reg b,
output reg c,
output reg d,
output reg e,
output reg f,
output reg g
);
reg A;
reg B;
reg C;
reg D;
reg W;
reg X;
reg Y;
reg Z;

reg [26:0] delay; //for delay of
1 second

initial begin
W<=0;
X<=0;
Y<=0;
Z<=0;
end
always @(posedge clk) begin

a=(!D&!C&!B&A) | (!D&C&!B&!A);
b=(!D&C&!B&A) | (!D&C&B&!A);

```

```

c = (!D&!C&B&!A) ;
d = (!D&!C&!B&A) | (!D&C&!B&!A) | (!D
&C&B&A) ;
e = (!D&!C&!B&A) | (!D&!C&B&A) | (!D&
C&!B&!A) | (!D&C&!B&A) | (!D&C&B
&A) | (D&!C&!B&A) ;
f = (!D&!C&!B&A) | (!D&!C&B&!A) | (!D
&!C&B&A) | (!D&C&B&A) ;
g = (!D&!C&!B&!A) | (!D&!C&!B&A) | (!
D&C&B&A) ;

D<=(W&X&Y&!Z) | (!W&!X&!Y&Z) ;
C<=(Y&!X) | (Y&!W) | (!Y&X&W) ;
B<=(!W&X) | (!Z&!X&W) ;
A<=!W;

delay = delay+1;

if( delay == 27'
    b101111101011110000100000000
)begin

delay=27'b0;
W<=A;
X<=B;
Y<=C;
Z<=D;
end

end
endmodule

```

Pin	Segment
A5	a
A2	b
C3	c
B4	d
B7	e
B6	f
B3	g
Vcc	COM

TABLE 2.0: Pin Connections

PCF\_File with decade\_counter.

- 5) Now open terminal and go to the Directory where all files are saved and type the following command.

**make**

- 6) Now the decade counter is observed.

- 2) Open a text editor and type the following and save it as decade\_counter.pcf

```

set_io clk R9
set_io a A5
set_io b A2
set_io c C3
set_io d B4
set_io e B7
set_io f B6
set_io g B3

```

- 3) Now connect icoboard to sevensegment display according to TABLE.2.0
- 4) Copy the Makefile into the same directory and replace V\_FNAME with decade\_counter, and