

VHDL I

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Mar. 2, 2012

1 Administrivia

Announcements

Assignment

From Last Time

Carry-lookahead and signed-digit addition.

Outline

1. VHDL program structure.
2. Structural VHDL.
3. Class practice.

Coming Up

VHDL II.

2 VHDL Program Structure

VHDL is **case insensitive**!!

1. Structure of a VHDL program:

```
Library includes;  
Entity declaration;  
Architectural definition of entity;
```

2. Library includes:

```
-- This is a comment.  
library ieee, lcdf_vhdl;  
use ieee.std_logic_1164.all, lcdf_vhdl_.func_prims.all;
```

Reserved words: library, use, .all.

Similar to import, include statements.

3. Entity declaration:

```
entity entity_name is  
    port(i0, i1, i2 : in std_logic;  
         o0          : out std_logic);  
end entity_name;
```

Reserved words: entity, is, port, in, out, end.

Note that `entity_name` follows `end`.

4. Architectural definition of entity:

```
architecture arch_name of entity_name is  
  
    component declarations;  
    signal declarations;  
  
    begin  
        VHDL statements;  
    end arch_name;
```

Reserved words: architecture, of, begin.

`entity_name` must match. `arch_name` is just a “place holder” — possible to describe an entity with multiple architectures.

Again, note that `arch_name` follows `end`.

5. Component declaration:

```
component component_name
  port(i0, i1 : in std_logic;
        o0    : out std_logic);
end component;
```

Reserved words: component.

Like base class declarations in C++.

6. Signal declarations:

```
signal s0, s1, s2 : std_logic;
```

Similar to variable declarations.

3 Structural VHDL

1. Describes structure of a circuit — similar to netlist. Low-level description.

2. Example: Three input EXOR.

Equation: $\bar{i}_2 \bar{i}_1 i_0 + \bar{i}_2 i_1 \bar{i}_0 + i_2 \bar{i}_1 \bar{i}_0 + i_2 i_1 i_0$

VHDL:

```
library ieee, lcdf_vhdl;
use ieee.std_logic_1164.all, lcdf_vhdl.func_prims.all;

entity EXOR3 is
  port(i2, i1, i0 : in std_logic;
        o          : out std_logic);
```

```
end EXOR3;
```

arch structural of EXOR3 is

```
component NOT1
  port(in1 : in std_logic;
        out1 : out std_logic);
end component;

component NAND3
  port(in1, in2, in3 : in std_logic;
        out1          : out std_logic);
end component;

component NAND4
  port(in1, in2, in3, in4 : in std_logic;
        out1              : out std_logic);
end component;

signal i2_n, i1_n, i0_n, t3, t2, t1, t0 : std_logic;

begin

  g0: NOT1 port map(i2, i2_n);
  g1: NOT1 port map(i1, i1_n);
  g2: NOT1 port map(i0, i0_n);

  g3: NAND3 port map(i2_n, i1_n, i0, t3);
  g4: NAND3 port map(i2_n, i1, i0_n, t2);
  g5: NAND3 port map(i2, i1_n, i0_n, t1);
  g6: NAND3 port map(i2, i1, i0, t0);

  g7: NAND4 port map(t3, t2, t1, t0, o);

end structural;
```

4 Class Practice

For EXOR3 circuit demonstrate Xilinx Project Navigator:

1. Project creation and settings for Digilent FPGA boards.

2. Library tab and set-up.

(If necessary, making a library file “global.”)

3. Syntax checking.

4. Synthesis.

5. Testbench creation

6. iSim simulation and zooming.

7. Implement and simulate EXOR3.

The source and library VHDL are on the class Web site. There are syntax errors in the source VHDL which you'll need to find and fix.