Project 1 Introduction

ECE 5484

What you need to do

1) Design a combinational logic circuit that displays the hexadecimal value of a Balanced Gray code input according to the specifications given in the assignment.

2) Debug and test your design by simulating it using the Logisim simulator.

3) Document your work in a short report.

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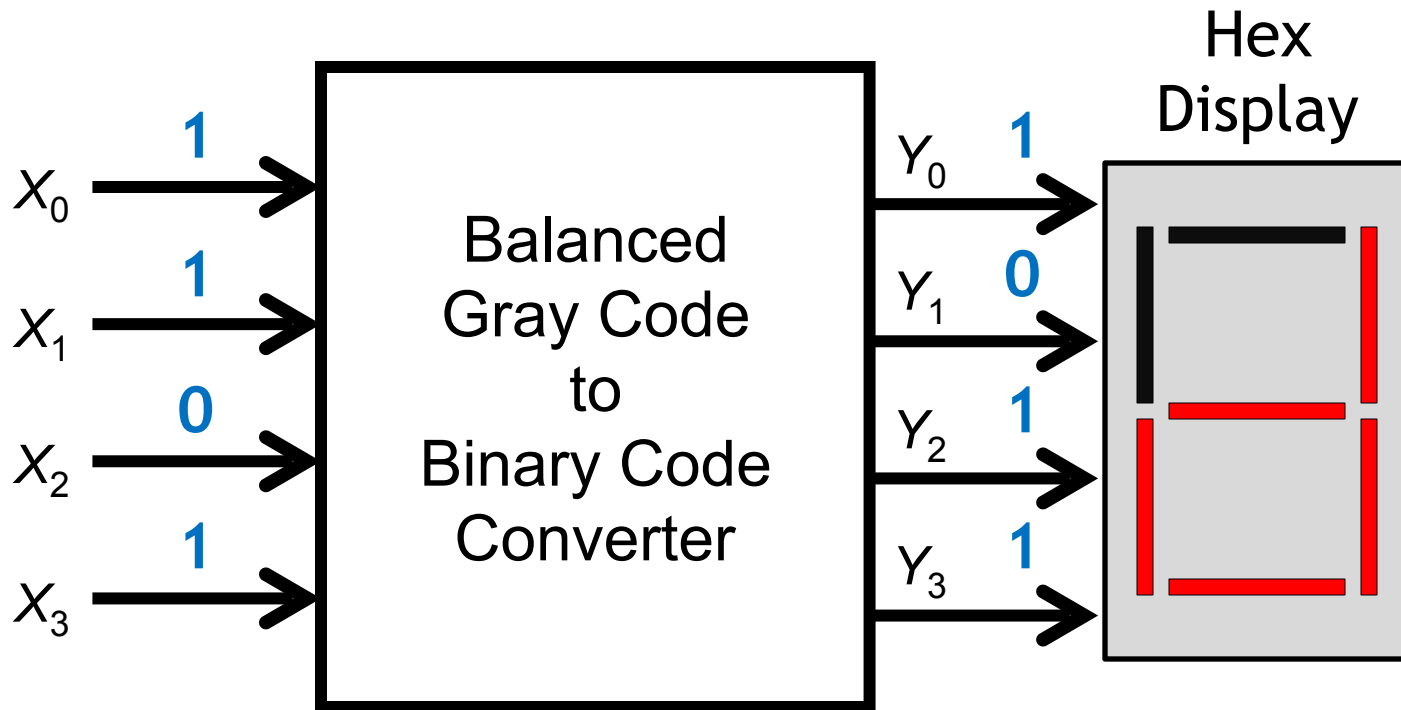
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Block Diagram

X_0

X_1

X_2

X_3

Balanced
Gray Code
to
Binary Code
Converter

Y_0

Y_1

Y_2

Y_3

Hex
Display
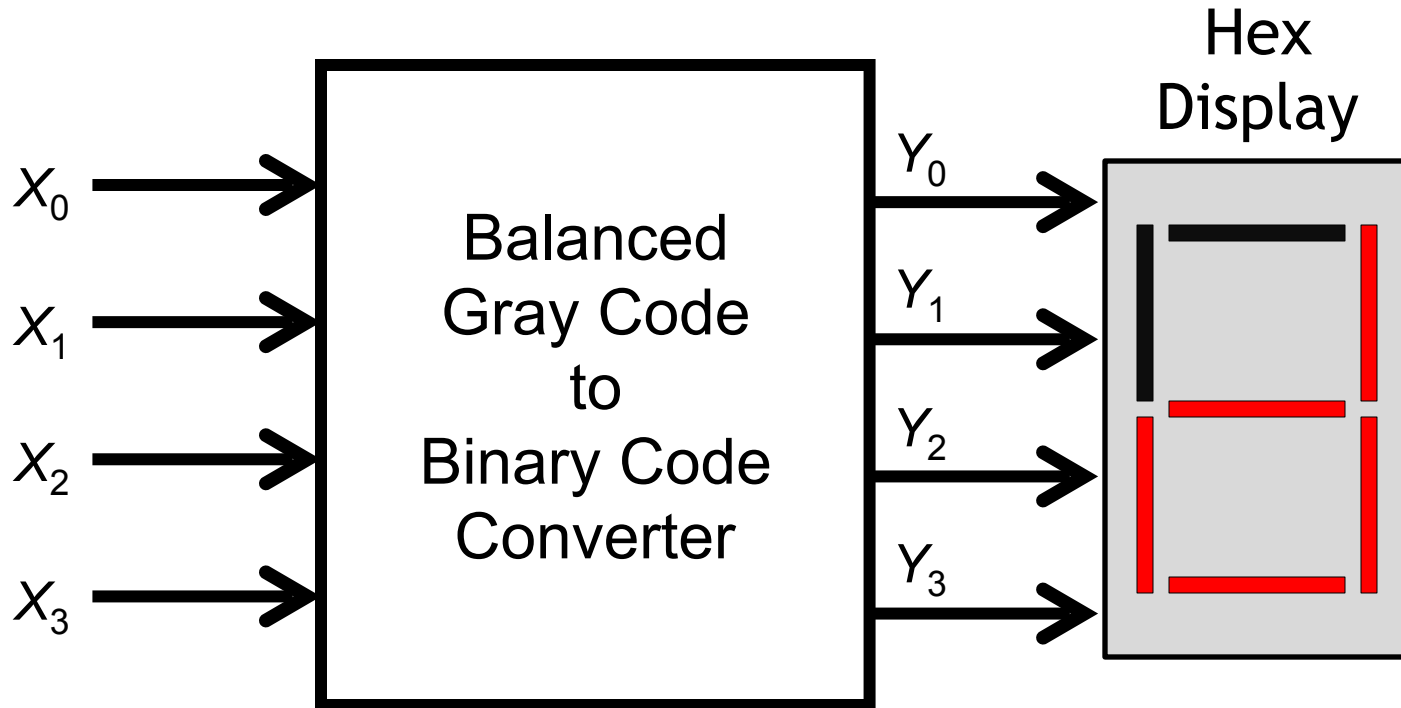
Code Definition

Hexadecimal Value	Balanced Gray Code $(X_3\, X_2\, X_1\, X_0)$	Binary Code $(Y_3\, Y_2\, Y_1\, Y_0)$
0	0 0 0 0	0 0 0 0
1	1 0 0 0	0 0 0 1
2	1 1 0 0	0 0 1 0
3	1 1 0 1	0 0 1 1
4	1 1 1 1	0 1 0 0
5	1 1 1 0	0 1 0 1
6	1 0 1 0	0 1 1 0
7	0 0 1 0	0 1 1 1
8	0 1 1 0	1 0 0 0
9	0 1 0 0	1 0 0 1
A	0 1 0 1	1 0 1 0
B	0 1 1 1	1 0 1 1
C	0 0 1 1	1 1 0 0
D	1 0 1 1	1 1 0 1
E	1 0 0 1	1 1 1 0
F	0 0 0 1	1 1 1 1

Conversion Example

Hex Display

X_0 — **1** → Balanced Gray Code to Binary Code Converter → Y_0 **1**

X_1 — **1** →

X_2 — **0** →

X_3 — **1** →

Y_1 **0**

Y_2 **1**
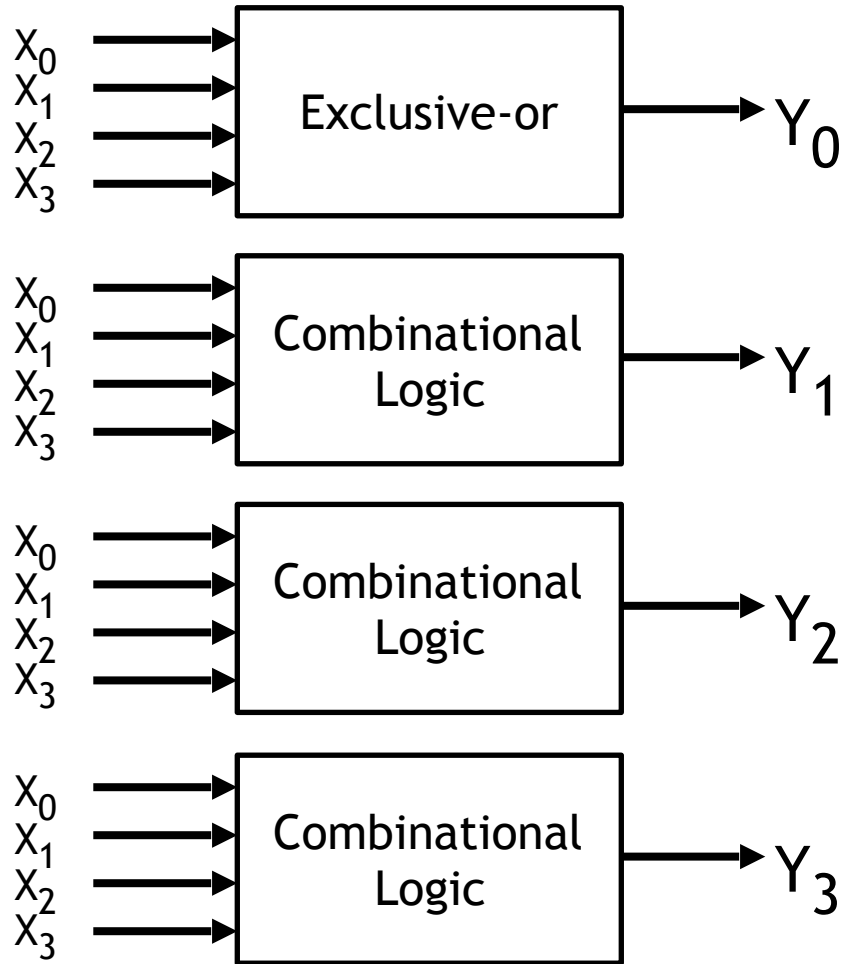
Y_3 **1**

$(X_3, X_2, X_1, X_0) = (1, 0, 1, 1)$

$(Y_3, Y_2, Y_1, Y_0) = (1, 1, 0, 1) = $ Hex "D"

Expression for Y_0

- Bit Y_0 is "1" if and only if an odd number of X bits are "1" (1 bit or 3 bits are "1")
- Thus, Y_0 is the exclusive-or (or modulo-2 sum) of the four X bits

$$Y_0 = X_3 \oplus X_2 \oplus X_1 \oplus X_0$$

Logic Blocks for Four Outputs

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Start of the Circuit in Logisim

Base Circuit Layout
Created by S. F. Midkiff

Inputs for Y1, Y2, and Y3 are temporary. They are to be replaced by combinational logic circuits to produce Y1, Y2, and Y3 from inputs X0, X1, X2, and X3.

Modeling and Simulation Tips

- Begin with the provided starter circuit
- Test Y_0 by setting different values of $X_3X_2X_1X_0$ and observe output Y_0
  - Change inputs by clicking on the X inputs
  - Observe logic values (bright green $\Rightarrow$ "1")
- Build <u>and test</u> the combinational logic for Y_1, then for Y_2, and, finally, for Y_3
- Test the full system by observing specified versus actual hexadecimal outputs for different input combinations

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Project 1: Report Content

- Name, email, title at the top of page 1
- Body of the Report
  - *Section 1 – Objectives* (What are you trying to do?)
  - *Section 2 – Truth Table* (Re-ordered version of table in the assignment)
  - *Section 3 – Logic Expressions* (What are the expressions and how did you derive them?)
  - *Section 4 – Circuit Design* (Show the circuit from Logisim)
  - *Section 5 – Conclusions*
- Cover the requested content, but keep it brief