Lab 1: FPGA-based Mental Binary Math Game

USER MANUAL

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# Introduction

The Mental Binary Math Game is a 2-player mental math game that tests the player’s understanding of binary and hexadecimal numbers. Players must be able to convert between binary and hexadecimal and add in binary to play this game.

The board has three main components that the players will be interacting with. There are two sections of four switches and three 7-segment displays. Player 1 will place inputs into the Player 1 switches. Player 2 will place inputs into the Player 2 switches. Figure 1 shows these areas marked. From left to right, the first display will show Player 1’s input as a hexadecimal number. The second display will show Player 2’s input as a hexadecimal number. The third display will show the sum of Player 1’s and Player 2’s inputs as a hexadecimal number.

A circuit board

Description automatically generated

**Player 1**

**Sum**

**Player 2**

**Figure 1.** DE2-115 FBGA Board. The red box shows the 4 switches that will be used for Player 1’s input and the corresponding display. The blue box shows the 4 switches that will be used for Player 2’s input and the corresponding display. The yellow box shows the display where the sum will appear.

# Instructions for game operation

This is a turn-based game. Player 1 will pick a number between 0000 and 1111 in binary and input that into the board using the switches designated for Player 1. The board will convert the binary input into a hexadecimal number that will appear on Player 1’s 7-segment display. Player 2 should look at this hexadecimal number and then using the Player 2 switches, input the binary number that they think will add with Player 1’s number to get to 1111 in binary (F in hexadecimal). Difficulty can be increased by implementing a time limit on Player 2’s turn. We recommend 5 seconds.

**Example 1: Failed Round**

Player 1 decides they want to input 1010 in binary. They type it in, and the Red display shows the letter A in hexadecimal.

Now it’s Player 2’s turn. They see the letter A and mentally convert that to binary. Player 2 thinks that A is equal to 1001 in binary, so Player 2 inputs 0110 using the Player 2 switches. The second display shows the number 6.

The sum displayed is 0. 1010 + 0110 = 10000, however, because the 7-segment display only works for 4-bit numbers for this game, the most significant digit is cut off. This is not F (1111 in binary) and so Player 2 does not get a point this round.

Now Player 1 and Player 2 switch places. Player 2 is now Player 1 and Player 1 is now Player 2.

**Example 2: Successful Round**

Player 1 decides to enter 1101 into the Player 1 switches. The display shows d.

Player 2 see’s the d on Player 1’s display and knows that is 1101 in binary. Player 2 enters 0010 into the board using his switches. Player 2’s display shows 2.

The sum displayed is F. That is binary 1111 and so Player 2 gets a point.

Player 1 and Player 2 switch places to start another round.