CPSC 359 Assignment 2: Gray Code Up/Down Counter

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1. **The Problem:**
   Adding or subtracting gray code values when a button is pushed, with an enable/disable button for the adder/subtractor logic
2. **Variable Symbolization:**
   Input Variables:
   D: direction
   E: enable
   Output Variables:
   G1, G2, G3: Gray code bits, with G1 being the least significant, G3 being the most, and G2 being in the middle.
   Flip Flops: A,B,C
3. **State Diagram:**

Present state			Next state, E = 1												Next state, E = 0, D = x					
			D = 0						D = 1						Output					
						Output						Output								
A	B	C	A	B	C	G1	G2	G3	A	B	C	G1	G2	G3	A	B	C	G1	G2	G3
0	0	0	0	0	1	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0
0	0	1	0	1	0	0	1	1	0	0	0	0	0	0	0	0	1	0	0	1
0	1	0	0	1	1	0	1	0	0	0	1	0	0	1	0	1	0	0	1	1
0	1	1	1	0	0	1	1	0	0	1	0	0	1	1	0	1	1	0	1	0
1	0	0	1	0	1	1	1	1	0	1	1	0	1	0	1	0	0	1	1	0
1	0	1	1	1	0	1	0	1	1	0	0	1	1	0	1	0	1	1	1	1
1	1	0	1	1	1	1	0	0	1	0	1	1	1	1	1	1	0	1	0	1
1	1	1	0	0	0	0	0	0	1	1	0	1	0	1	1	1	1	1	0	0

4. **Input and Output Variables:**
   Input Variables:
   Direction: whether to add or subtract the gray code
   Enable: whether or not to add or subtract the gray code
   Output Variables: 3-bit gray code
   Flip-Flops required: 3 JK flip-flops

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5. **Excitation Table:**

Combinational Circuit Inputs					Next state			Combinational Circuit Outputs					
Present state			Input					Flip-Flop Inputs					
A	B	C	D	E	A	B	C	J_A	K_A	J_B	K_B	J_C	K_C
0	0	0	x	0	0	0	0	0	0	0	0	0	0
0	0	1	x	0	0	0	1	0	0	0	0	0	0
0	1	0	x	0	0	1	0	0	0	0	0	0	0
0	1	1	x	0	0	1	1	0	0	0	0	0	0
1	0	0	x	0	1	0	0	0	0	0	0	0	0
1	0	1	x	0	1	0	1	0	0	0	0	0	0
1	1	0	x	0	1	1	0	0	0	0	0	0	0
1	1	1	x	0	1	1	1	0	0	0	0	0	0
0	0	0	0	1	0	0	1	0	0	0	0	1	1
0	0	1	0	1	0	1	0	0	0	1	1	1	1
0	1	0	0	1	0	1	1	0	0	0	0	1	1
0	1	1	0	1	1	0	0	1	1	1	1	1	1
1	0	0	0	1	1	0	1	0	0	0	0	1	1
1	0	1	0	1	1	1	0	0	0	1	1	1	1
1	1	0	0	1	1	1	1	0	0	0	0	1	1
1	1	1	0	1	0	0	0	1	1	1	1	1	1
0	0	0	1	1	1	1	1	1	1	1	1	1	1
0	0	1	1	1	0	0	0	0	0	0	0	1	1
0	1	0	1	1	0	0	1	0	0	1	1	1	1
0	1	1	1	1	0	1	0	0	0	0	0	1	1
1	0	0	1	1	0	1	1	1	1	1	1	1	1
1	0	1	1	1	1	0	0	0	0	0	0	1	1
1	1	0	1	1	1	0	1	0	0	1	1	1	1
1	1	1	1	1	1	1	0	0	0	0	0	1	1

6. **Circuit Output Functions:**
   Please see handwritten page 1 for circuit output functions.
7. **Flip-flop Input Functions:**
   Please see handwritten page 2 and 3 for flip flop input functions.
8. **Implementation of Logic Diagrams:**
   Please see handwritten page 4 of the report for implemented logic diagrams.

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1. **Bonus Input and Output Variables:**
   Input Variables:
   Direction: whether to add or subtract the gray code
   Enable: whether or not to add or subtract the gray code
   Output Variables: 3-bit gray code
   Flip-Flops required: 3 T flip-flops
2. **Bonus Excitation Table:**

Combinational Circuit Inputs					Next state			Combinational Circuit Outputs		
Present state			Input					Flip-Flop Inputs		
A	B	C	D	E	A	B	C	T_A	T_B	T_C
0	0	0	x	0	0	0	0	0	0	0
0	0	1	x	0	0	0	1	0	0	0
0	1	0	x	0	0	1	0	0	0	0
0	1	1	x	0	0	1	1	0	0	0
1	0	0	x	0	1	0	0	0	0	0
1	0	1	x	0	1	0	1	0	0	0
1	1	0	x	0	1	1	0	0	0	0
1	1	1	x	0	1	1	1	0	0	0
0	0	0	0	1	0	0	1	0	0	1
0	0	1	0	1	0	1	0	0	1	1
0	1	0	0	1	0	1	1	0	0	1
0	1	1	0	1	1	0	0	1	1	1
1	0	0	0	1	1	0	1	0	0	1
1	0	1	0	1	1	1	0	0	1	1
1	1	0	0	1	1	1	1	0	0	1
1	1	1	0	1	0	0	0	1	1	1
0	0	0	1	1	1	1	1	1	1	1
0	0	1	1	1	0	0	0	0	0	1
0	1	0	1	1	0	0	1	0	1	1
0	1	1	1	1	0	1	0	0	0	1
1	0	0	1	1	0	1	1	1	1	1
1	0	1	1	1	1	0	0	0	0	1
1	1	0	1	1	1	0	1	0	1	1
1	1	1	1	1	1	1	0	0	0	1

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3. **Bonus Circuit Output Functions:**
   Please see handwritten page 1 for circuit output functions. It will be the same as the original circuit.
4. **Bonus Flip-flop Input Functions:**
   Please see handwritten page 5 for flip flop input functions.
5. **Bonus Implementation of Logic Diagrams:**
   Please see handwritten page 6 of the report for implemented logic diagrams.