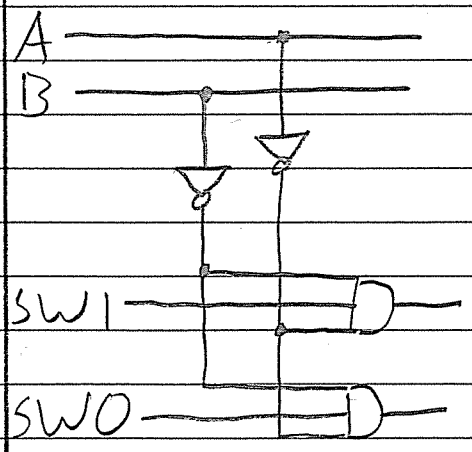
Switches	Output	
00 = 0¢	000 = 0¢	100 = 20¢
01 = 5¢	001 = 5¢	101 = 25¢
10 = 10¢	010 = 10¢	110 = 30¢
11 = 25¢	011 = 15¢	111 = 35¢

Hex Output

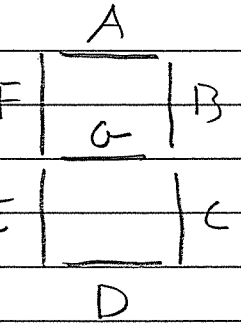
	A	B	C	D	E	F	G
0	1	1	1	1	1	1	0
1	0	1	1	0	0	0	0
2	1	1	0	1	1	0	1
3	1	1	1	1	0	0	1
5	1	0	1	1	0	1	1
A	1	1	1	0	1	1	1
b	0	0	1	1	1	1	1

Preference of Purchace

A10 and B25 passed through not gates, then an and gate for each switch SW



Purchace overrides coin input



Flip-Flop Logic

Switches SW_1 and SW_2 are input coins described previously. They are added to current state. Then they are passed through Mealy machine to next state.

Current state Y

Next state Q

			$SW_1 SW_0$ = 00	01	10	11
Y_2	Y_1	Y_0				
0	0	0	000	001	010	101
0	0	1	001	010	011	110
0	1	0	010	011	100	111
0	1	1	011	100	101	011
1	0	0	100	101	110	100
1	0	1	101	110	111	101
1	1	0	110	111	110	110
1	1	1	111	111	111	111

Y_2	Y_1	Y_0	SW_1	SW_0	Q_2	Q_1	Q_0	LED
0	0	0	0	0	0	0	0	0
0	0	0	0	1	0	0	1	0
0	0	0	1	0	0	1	0	0
0	0	0	1	1	1	0	1	0
0	0	1	0	0	0	0	1	0
0	0	1	0	1	0	1	0	0
0	0	1	1	0	0	1	1	0
0	0	1	1	1	1	1	0	0
0	1	0	0	0	0	1	0	0
0	1	0	0	1	0	1	1	0
0	1	0	1	0	1	0	0	0
0	1	0	1	1	1	1	1	0
0	1	1	0	0	0	1	1	0
0	1	1	0	1	1	0	0	0
0	1	1	1	0	1	0	1	0
0	1	1	1	1	1	1	1	1
1	0	0	0	0	1	0	0	0
1	0	0	0	1	1	0	1	0
1	0	0	1	0	1	1	0	0
1	0	0	1	1	1	0	0	1
1	0	1	0	0	1	0	1	0
1	0	1	0	1	1	1	0	0
1	0	1	1	0	1	1	1	0
1	0	1	1	1	1	0	1	1
1	1	0	0	0	1	1	0	0
1	1	0	0	1	1	1	1	0
1	1	0	1	0	1	1	0	1
1	1	0	1	1	1	1	0	1
1	1	1	0	0	1	1	1	0
1	1	1	0	1	1	1	1	1
1	1	1	1	0	1	1	1	1
1	1	1	1	1	1	1	1	1

Q_2

Y_1Y_0 \ SW_1SW_0	00	01	11	10
00	0	0	0	0
01	0	0	1	0
11	1	1	0	1
10	0	0	1	1

$(\overline{Y}_1 SW_1 SW_0 + \overline{Y}_0 SW_1 SW_0 + Y_1 SW_1 \overline{SW}_0 + Y_1 Y_0 \overline{SW}_1 SW_0)$

Y_1Y_0 \ SW_1SW_0	00	01	11	10
00	1	1	1	1
01	1	1	1	1
11	1	1	1	1
10	1	1	1	1

1

Q_1

Y_1Y_0 \ SW_1SW_0	00	01	11	10
00	0	0	1	1
01	0	1	0	1
11	0	1	1	1
10	1	1	0	0

$(Y_1 \overline{SW}_1 \overline{SW}_0 + Y_1 Y_0 SW_0 + \overline{Y}_1 SW_1 \overline{SW}_0 + Y_0 \overline{SW}_1 SW_0 + \overline{Y}_1 Y_0 SW_0)$

Y_1Y_0 \ SW_1SW_0	00	01	11	10
00	0	0	1	1
01	0	1	1	1
11	0	0	1	1
10	1	1	1	1

$(Y_1 + SW_1 SW_0 + Y_0 \overline{SW}_1 SW_0)$

Q_0

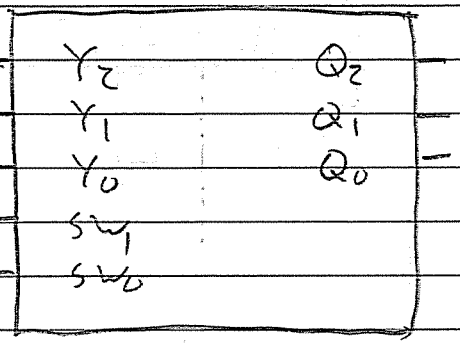
Y_1Y_0 \ SW_1SW_0	00	01	11	10
00	0	1	1	0
01	1	0	0	1
11	1	0	1	1
10	0	1	1	0

$(Y_0 \overline{SW}_0 + \overline{Y}_0 SW_1 + Y_1 \overline{SW}_1 SW_0)$

Y_1Y_0 \ SW_1SW_0	00	01	11	10
00	0	1	1	0
01	1	0	1	1
11	0	1	1	0
10	0	1	1	0

$(Y_1 \overline{Y}_0 + Y_0 SW_1 + \overline{Y}_0 \overline{SW}_1 SW_0 + Y_0 \overline{SW}_0)$

Flip-Flop Logic



$$Q_2 = Y_2 + \overline{Y_2}(\overline{Y_1} SW_1 SW_0 + \overline{Y_0} SW_1 SW_0 + Y_1 SW_1 \overline{SW_0} + Y_1 Y_0 \overline{SW_1} SW_0)$$

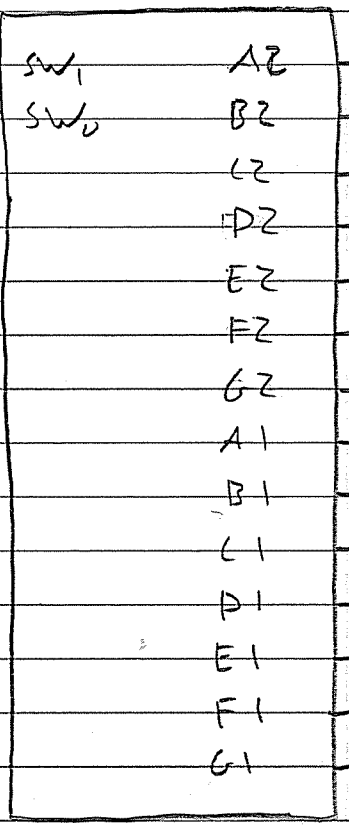
$$Q_1 = \overline{Y_2}(Y_1 \overline{SW_1}\,\overline{SW_0} + Y_1 \overline{Y_0} SW_0 + \overline{Y_1} SW_1 \overline{SW_0} + Y_0 SW_1 SW_0 + \overline{Y_1} Y_0 SW_0) + Y_2(Y_1 + SW_1 \overline{SW_0} + Y_0 \overline{SW_1} SW_0)$$

$$Q_0 = \overline{Y_2}(Y_0 SW_0 + \overline{Y_0} SW_0 + Y_1 SW_1 SW_0) + Y_2(Y_1 Y_0 + Y_0 SW_1 + \overline{Y_0} \overline{SW_1} SW_0 + Y_0 \overline{SW_0})$$

Coin Input to Machine

SW_1 SW_0	Hex2	Hex1
0 0	0	0
0 1	0	5
1 0	1	0
1 1	2	5

All following logic underwent not in verilog because 1 means off and 0 means on for the hex LEDs.



$A1 = 1$
$B1 = \overline{SW_0}$
$C1 = 1$
$D1 = 1$
$E1 = \overline{SW_0}$
$F1 = 1$
$G1 = SW_0$

$A2 = \overline{SW_1} + SW_0$
$B2 = 1$
$C2 = \overline{SW_1} + SW_0$
$D2 = \overline{SW_1} + SW_0$
$E2 = \overline{SW_1} + SW_0$
$F2 = \overline{SW_1}$
$G2 = \overline{SW_1} SW_0$

Hex 2

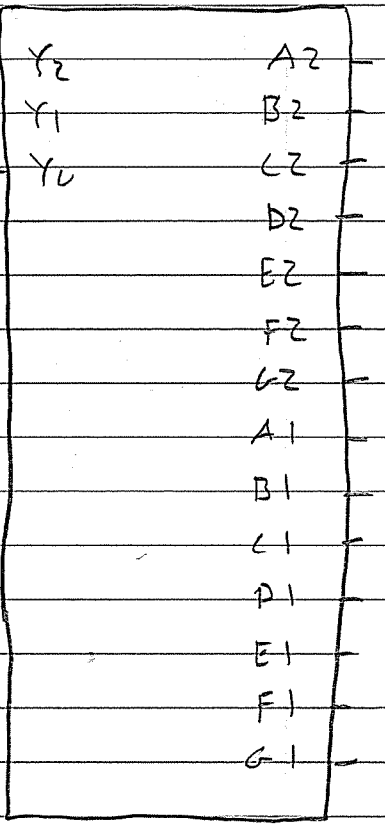
SW_1	SW_0	A	B	C	D	E	F	G
0	0	1	1	1	1	1	1	0
0	1	1	1	1	1	1	1	0
1	0	0	1	1	0	0	0	0
1	1	1	1	0	1	1	0	1

Hex 1

SW_1	SW_0	A	B	C	D	E	F	G
0	0	1	1	1	1	1	1	0
0	1	1	0	1	1	0	1	1
1	0	1	1	1	1	1	1	0
1	1	1	0	1	1	0	1	1

Coin Output

Y_2	Y_1	Y_0	Hex 2	Hex 1
0	0	0	0	0
0	0	1	0	5
0	1	0	1	0
0	1	1	1	5
1	0	0	2	0
1	1	1	2	5
1	0	0	3	0
1	1	1	3	5



All logic passed through not in verilog due to hex on/off logic.
Coin output placed after purchace machine to display change return as well as change currently in machine

$A1 = 1$
$B1 = \overline{Y_0}$
$C1 = 1$
$D1 = 1$
$E1 = \overline{Y_0}$
$F1 = 1$
$G1 = \overline{Y_0}$

$A2 = Y_2 + \overline{Y_1}$
$B2 = 1$
$C2 = Y_2 + \overline{Y_1}$
$D2 = Y_2 + \overline{Y_1}$
$E2 = \overline{Y_1}$
$F2 = \overline{Y_2}\,\overline{Y_1}$
$G2 = \overline{Y_2}$

Hex 2

Y_2	Y_1	A	B	C	D	E	F	G
0	0	1	1	1	1	1	1	0
0	1	0	1	1	0	0	0	0
1	0	1	1	0	1	1	1	1
1	1	1	1	1	1	0	0	1

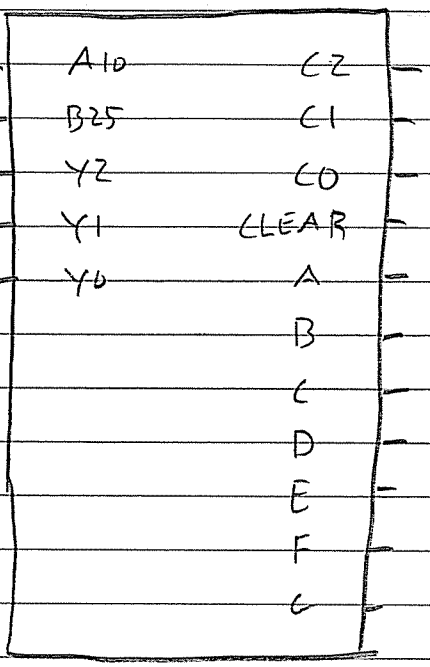
Hex 1

Y_0	A	B	C	D	E	F	G
0	1	1	1	1	1	1	0
1	1	0	1	1	0	1	1

Inputs Y_2 and Y_1 only affected Hex 2
Similarly, Hex 1 was only dependent on Y_0

Purchase/Change/Clear

Since directions were unclear, I designed this section as follows. Purchase designates if A10, B25, or nothing is purchaced. Change displays on two hexes how much change in the machine is returned.



Clear output was passed throug a D flip-flop on the same clock as the state machine. Clear resets the state machine, enabling more purchaces

B2	B1	B0	Y_2	Y_1	Y_0	C_2	C_1	C_0	CLEAR	Hex
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	1	0	0	0	0	1
0	0	0	0	1	0	0	0	0	0	2
0	0	0	0	1	1	0	0	0	0	3
0	0	1	0	0	0	0	0	0	0	4
0	0	1	0	0	1	0	0	0	0	5
0	0	1	0	1	0	0	0	0	0	6
0	0	1	0	1	1	0	0	0	0	7
0	1	0	0	0	0	0	0	0	0	8
0	1	0	0	0	1	0	0	0	0	9
0	1	0	0	1	0	0	0	0	1	A
0	1	0	0	1	1	0	0	1	1	A
0	1	1	0	0	0	0	1	0	1	A
0	1	1	0	0	1	0	1	1	1	A
0	1	1	1	0	0	1	0	0	1	A
0	1	1	1	1	0	1	0	1	1	A
1	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	1	0	0	0	0	1
1	0	0	0	1	0	0	0	0	0	2
1	0	0	0	1	1	0	0	0	0	3
1	0	1	0	0	0	0	0	0	0	4
1	0	1	0	0	1	0	0	0	1	b
1	0	1	0	1	0	0	0	1	1	b
1	0	1	0	1	1	0	1	0	1	b
1	1	0	0	0	0	0	0	0	1	0
1	1	0	0	0	1	0	0	1	1	0
1	1	0	0	1	0	0	1	0	1	0
1	1	0	0	1	1	0	1	1	1	0
1	1	1	0	0	0	1	0	0	1	0
1	1	1	0	0	1	1	0	1	1	0
1	1	1	0	1	0	1	1	0	1	0
1	1	1	0	1	1	1	1	1	1	0

Hex	A	B	C	D	E	F	G
2	1	1	1	1	1	1	0
5	1	1	1	1	1	1	0
9	1	1	1	1	1	1	0
C	1	1	1	1	1	1	0
1	1	1	1	1	1	1	0
3	1	1	1	1	1	1	0
7	1	1	1	1	1	1	0
F	1	1	1	1	1	1	0
8	1	1	1	1	1	1	0
9	1	1	1	1	1	1	0
A	1	1	1	0	1	1	1
A	1	1	1	0	1	1	1
A	1	1	1	0	1	1	1
A	1	1	1	0	1	1	1
A	1	1	1	0	1	1	1
A	1	1	1	0	1	1	1
D	1	1	1	1	1	1	0
D	1	1	1	1	1	1	0
D	1	1	1	1	1	1	0
D	1	1	1	1	1	1	0
0	1	1	1	1	1	1	0
6	0	0	1	1	1	1	1
6	0	0	1	1	1	1	1
6	0	0	1	1	1	1	1
7	1	1	1	1	1	1	0
7	1	1	1	1	1	1	0
7	1	1	1	1	1	1	0
7	1	1	1	1	1	1	0
0	1	1	1	1	1	1	0
0	1	1	1	1	1	1	0
2	1	1	1	1	1	1	0
0	1	1	1	1	1	1	0

Purchase Hex

$A = B$

Y_1Y_0 \ AY_2B	000	001	011	010
00	1	1	1	1
01	1	0	1	1
11	1	0	1	1
10	1	0	1	1

$(A\bar{1}0 + \bar{Y}_2 + \bar{Y}_1\bar{Y}_0)B\bar{2}5 + \bar{B}25$

$C = E = F = 1$

D

Y_1Y_0 \ AY_2	00	01	11	10
00	1	1	0	1
01	1	1	0	1
11	1	1	0	0
10	1	1	0	0

$B25(\overline{A10} + \bar{Y}_2\bar{Y}_1) + \bar{B}25$

G

Y_1Y_0 \ $AY_2\bar{B}25$	00	01	11	10
00	0	0	1	0
01	0	0	1	0
11	0	0	1	1
10	0	0	1	1

$A\bar{1}0\bar{Y}_2 + A\bar{1}0Y_1$

Y_1Y_0 \ AY_2B25	00	01	11	10
00	0	0	0	0
01	0	1	0	0
11	0	1	0	0
10	0	1	0	0

$\overline{A10}Y_2Y_0 + \overline{A10}Y_2Y_1$

C_2

AY_2 \ Y_1Y_0	00	01	11	10
00	0	0	0	0
01	0	0	0	0
11	0	0	1	0
10	0	0	1	0

$A\overline{10}Y_2Y_1$

AY_2 \ Y_1Y_0	00	01	11	10
00	0	0	1	0
01	0	0	1	0
11	0	0	1	0
10	0	0	1	0

$A\overline{10}Y_2$

C_1

AY_2 \ Y_1Y_0	00	01	11	10
00	0	0	1	0
01	0	0	1	0
11	0	0	0	0
10	0	0	0	0

$A\overline{10}Y_2\overline{Y}_1$

AY_2 \ Y_1Y_0	00	01	11	10
00	0	0	0	0
01	0	0	0	0
11	0	1	1	1
10	0	0	1	1

$(A\overline{10}Y_1 + Y_2Y_1Y_0)$

C_0

AY_2 \ Y_1Y_0	00	01	11	10
00	0	0	0	0
01	0	0	1	0
11	0	0	1	1
10	0	0	0	0

$(A\overline{10}Y_2Y_0 + A\overline{10}Y_1Y_0)$

AY_2 \ Y_1Y_0	00	01	11	10
00	0	0	0	0
01	0	0	1	1
11	0	0	1	1
10	0	1	0	0

$(A\overline{10}Y_0 + \overline{A10}Y_2Y_1Y_0)$

CLEAR

AY_2 / Y_1Y_2	$\overline{B25}$ 00	01	11	10
00	0	0	1	0
01	0	0	1	0
11	0	0	1	1
10	0	0	1	1

$(A10Y_2 + A10Y_1)$

AY_2 / Y_1Y_0	$B25$ 00	01	11	10
00	0	0	1	1
01	0	1	1	1
11	0	1	1	1
10	0	1	1	1

$(A10 + Y_2Y_0 + Y_2Y_1)$

$$CLEAR = \overline{B25}(A10Y_2 + A10Y_1) + B25(A10 + Y_2Y_0 + Y_2Y_1)$$

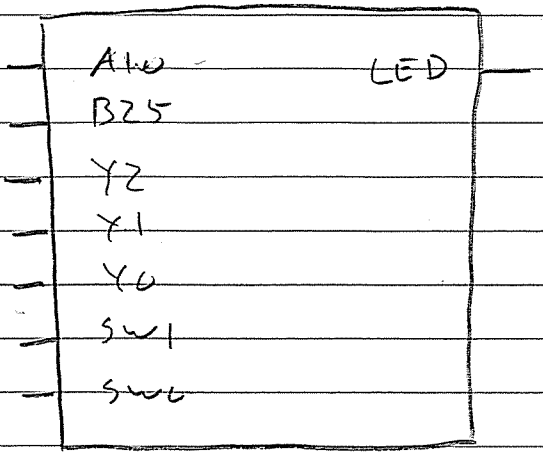
$$C2 = \overline{B25}(A10Y_2Y_1) + B25A10Y_2$$

$$C1 = A10Y_2\overline{Y_1}\,\overline{B25} + B25(A10Y_1 + Y_2Y_1Y_0)$$

$$C0 = \overline{B25}(A10Y_2Y_0 + A10Y_1\overline{Y_0}) + B25(A10Y_0 + \overline{A10}\,Y_2Y_1Y_0)$$

$$A = \overline{B25} + B25(A10 + Y_2 + \overline{Y_1}\,Y_0)$$
$$B = \overline{B25} + B25(A10 + Y_2 + \overline{Y_1}\,Y_0)$$
$$C = 1$$
$$D = B25 + \overline{B25}(\overline{A10} + \overline{Y_2}Y_1)$$
$$E = 1$$
$$F = 1$$
$$G = \overline{B25}(A10Y_2 + A10Y_1) + B25(\overline{A10}Y_2Y_0 + A10Y_2Y_1)$$

Coin Rejection



A10/B25	SW_1	SW_0	LED
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

SW_0 \ A/B SW_1	00	01	11	10
0	0	0	1	0
1	0	0	1	1

$$A10(SW_1 + SW_0) + B25(SW_1 + SW_0)$$

LED

Y_1Y_0 / SW_1SW_0	00	01	11	10
00	0	0	0	0
01	0	0	0	0
11	0	0	1	0
10	0	0	0	0

$Y_1 Y_0 SW_1 SW_0$

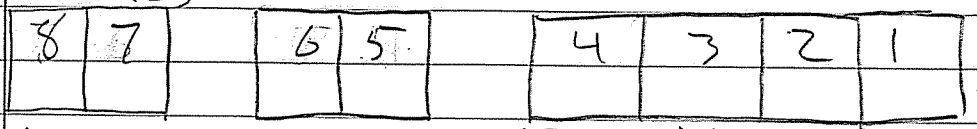
Y_1Y_0 : Y_2 / SW_1SW_0	00	01	11	10
00	0	0	0	0
01	0	0	1	0
11	1	1	1	1
10	0	0	1	1

$(SW_1 SW_0 + Y_1 SW_1 + Y_1 Y_0 SW_0)$

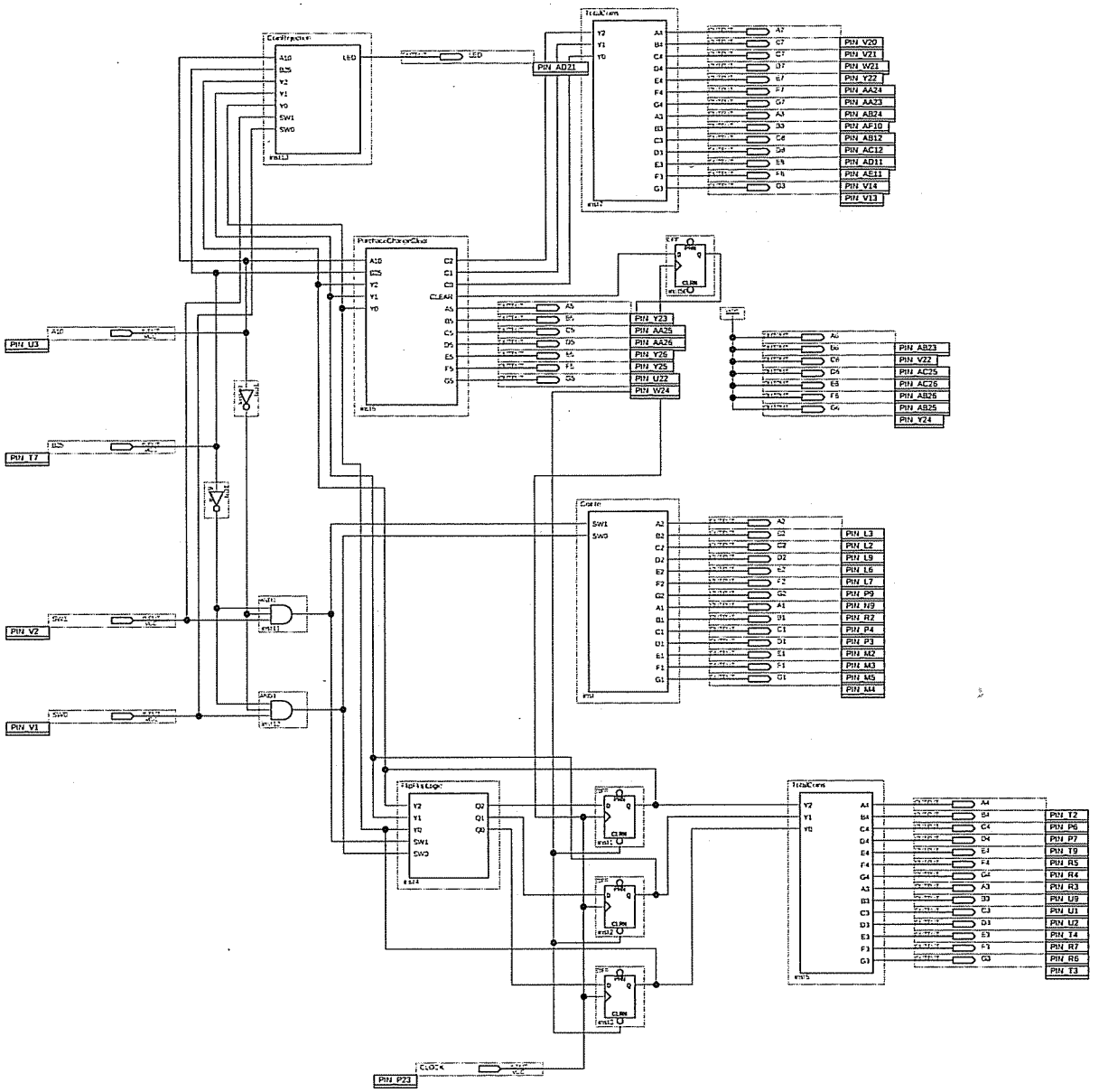
$$LED = A10(SW_1 + SW_0) + \overline{B}(SW_1 + SW_0) + \overline{Y_2} Y_1 Y_0 SW_1 SW_0 + (SW_1 SW_0 + Y_1 SW_1 + Y_1 Y_0 SW_0) Y_2$$

SW_1 = SW17
SW_0 = SW16
A10 = SW14
B25 = SW13
CLOCK = KEY2

Hexes



Coins Entered | Current Change | Item X Purchased | Change returned


PIN_U3
PIN_T7
PIN_V2
PIN_V1
PIN_AD21
LED
PIN_V20
PIN_V21
PIN_W21
PIN_Y22
PIN_AA24
PIN_AA23
PIN_AB24
PIN_AF10
PIN_AB12
PIN_AC12
PIN_AD11
PIN_AE11
PIN_V14
PIN_V13
PIN_Y23
PIN_AA25
PIN_AA26
PIN_Y26
PIN_Y25
PIN_U22
PIN_W24
PIN_AB23
PIN_V22
PIN_AC25
PIN_AC26
PIN_AB26
PIN_AB25
PIN_Y24
PIN_L3
PIN_L2
PIN_L9
PIN_L6
PIN_L7
PIN_P9
PIN_N9
PIN_R2
PIN_P4
PIN_P3
PIN_M2
PIN_M3
PIN_M5
PIN_M4
PIN_T2
PIN_P6
PIN_P7
PIN_T9
PIN_R5
PIN_R4
PIN_R3
PIN_U9
PIN_U1
PIN_U2
PIN_T4
PIN_R7
PIN_R6
PIN_T3
PIN_P23

```
2       input Y2, Y1, Y0, SW1, SW0;
3       output Q2, Q1, Q0;
4
5       assign Q2 = Y2|(~Y2&((~Y1&SW1&SW0)|(~Y0&SW1&SW0)|(Y1&SW1&~SW0)|(Y1&Y0&~SW1&SW0
        )));
6       assign Q1 = (~Y2&((Y1&~SW1&~SW0)|(Y1&~Y0&SW0)|(~Y1&SW1&~SW0)|(Y0&SW1&SW0)|(~Y1
        &Y0&SW0)))|(Y2&(Y1|(SW1&~SW0)|(Y0&~SW1&SW0)));
7       assign Q0 = (~Y2&((Y0&~SW0)|(~Y0&SW0)|(Y1&SW1&SW0)))|(Y2&((Y1&Y0)|(Y0&SW1)|(~
        Y0&~SW1&SW0)|(Y0&~SW0)));
8
9   endmodule
```

```
    D5, E5, F5, G5);
 2      input A10, B25, Y2, Y1, Y0;
 3      output C2, C1, C0, A5, B5, C5, D5, E5, F5, G5, CLEAR;
 4
 5      assign CLEAR = ~((~B25&((A10&Y2)|(A10&Y1)))|(B25&(A10|(Y2&Y0)|(Y2&Y1))));
 6      assign C2 = (~B25&A10&Y2&Y1)|(B25&A10&Y2);
 7      assign C1 = (~B25&A10&Y2&~Y1)|(B25&((A10&Y1)|(Y2&Y1&Y0)));
 8      assign C0 = (~B25&((A10&Y2&Y0)|(A10&Y1&Y0)))|(B25&((A10&Y0)|(~A10&Y2&Y1&~Y0)));
 9      assign A5 = ~((~B25)|(B25&(A10|~Y2|(~Y1&~Y0))));
10      assign B5 = ~((~B25)|(B25&(A10|~Y2|(~Y1&~Y0))));
11      assign C5 = 0;
12      assign D5 = ~((B25)|(~B25&(~A10|(~Y2&~Y1))));
13      assign E5 = 0;
14      assign F5 = 0;
15      assign G5 = ~((~B25&((A10&Y2)|(A10&Y1)))|(B25&((~A10&Y2&Y0)|(~A10&Y2&Y1))));
16
17  endmodule
```

```
    G3);
 2      input Y2, Y1, Y0;
 3      output A4, B4, C4, D4, E4, F4, G4, A3, B3, C3, D3, E3, F3, G3;
 4
 5      assign A3 = 0;
 6      assign B3 = Y0;
 7      assign C3 = 0;
 8      assign D3 = 0;
 9      assign E3 = Y0;
10      assign F3 = 0;
11      assign G3 = ~Y0;
12      assign A4 = ~(Y2|~Y1);
13      assign B4 = 0;
14      assign C4 = ~(~Y2|Y1);
15      assign D4 = ~(Y2|~Y1);
16      assign E4 = Y1;
17      assign F4 = ~(~Y2&~Y1);
18      assign G4 = ~Y2;
19
20  endmodule
```

```
2       input A10, B25, I2, I1, I0, SW1, SW0;
3       output LED;
4
5       assign LED = (A10&(SW1|SW0))|(B25&(SW1|SW0))|(~Y2&Y1&Y0&SW1&SW0)|(Y2&((SW1&SW0
    ))|(Y1&SW1)|(Y1&Y0&SW0)));
6
7   endmodule
```

```
2       input SW1, SW0;
3       output A2, B2, C2, D2, E2, F2, G2, A1, B1, C1, D1, E1, F1, G1;
4
5       assign A1 = 0;
6       assign B1 = SW0;
7       assign C1 = 0;
8       assign D1 = 0;
9       assign E1 = SW0;
10      assign F1 = 0;
11      assign G1 = ~SW0;
12      assign A2 = ~(~SW1|SW0);
13      assign B2 = 0;
14      assign C2 = ~(~SW1|~SW0);
15      assign D2 = ~(~SW1|SW0);
16      assign E2 = ~(~SW1|SW0);
17      assign F2 = SW1;
18      assign G2 = ~(SW1&SW0);
19
20  endmodule
```

Excellent Design Description Docs.

Docs : +20/20

Overall : 100/100