

# Unsigned Multiplier

**Nahin Ul Sadad**  
**Lecturer,**  
**CSE, RUET**

# Unsigned Multiplication Example

For unsigned number,

$$\begin{array}{r} 1011 \quad (+11) \\ 1101 \quad (+13) \\ \hline 00001011 \\ 0000000X \\ 001011XX \\ 01011XXX \\ \hline 10001111 \quad (+143) \end{array}$$

The “Binary”  
Multiplication  
Table

|   |   |   |
|---|---|---|
| * | 0 | 1 |
| 0 | 0 | 0 |
| 1 | 0 | 1 |

We can see that  
multiplying 2 4-bit (unsigned) binary numbers results in 8-bit binary number.

# Unsigned Multiplier Design

For unsigned number,

|   |    |    |    |    |
|---|----|----|----|----|
|   | X3 | X2 | X1 | X0 |
| x | Y3 | Y2 | Y1 | Y0 |

X = Multiplicand

Y = Multiplier

Z = Product

---

|  |      |      |      |      |
|--|------|------|------|------|
|  | X3Y0 | X2Y0 | X1Y0 | X0Y0 |
|  | X3Y1 | X2Y1 | X1Y1 | X0Y1 |
|  | X3Y2 | X2Y2 | X1Y2 | X0Y2 |
|  | X3Y3 | X2Y3 | X1Y3 | X0Y3 |

---

Every line in multiplication  
is called **Partial Product**.

1. We can perform AND operation with every Multiplicand bit (A3-A0) and current Multiplier bit (B0)
2. We can perform ADD operation between current line and previous line.
3. We should also consider carry bit of each addition that will propagate to next bit

# Unsigned Multiplier Building Block

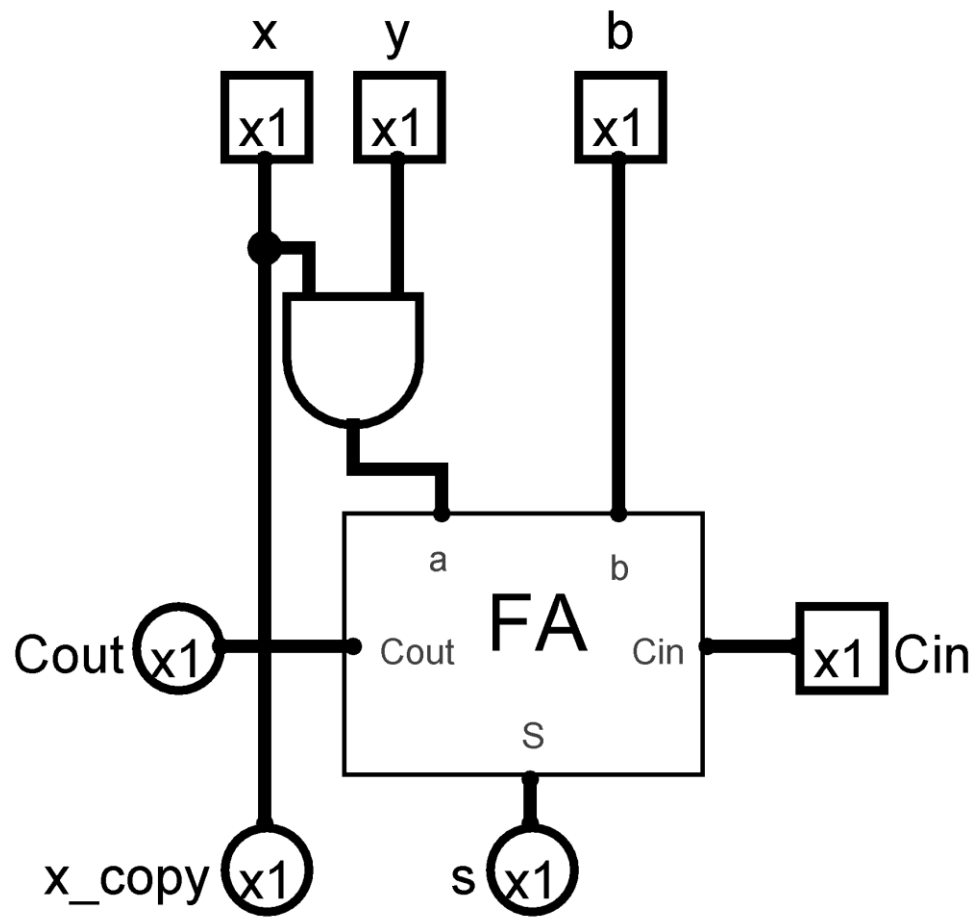
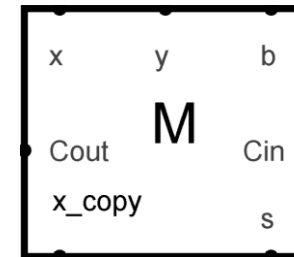
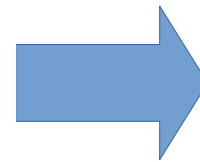


Figure: Cell M (Building Block)



$$Cout, S = (X \text{ AND } Y) \text{ ADD } A \text{ ADD } B$$

We are going to use a building block (Cell M) to create unsigned multiplier.

# 2 \* 2 Unsigned Multiplier

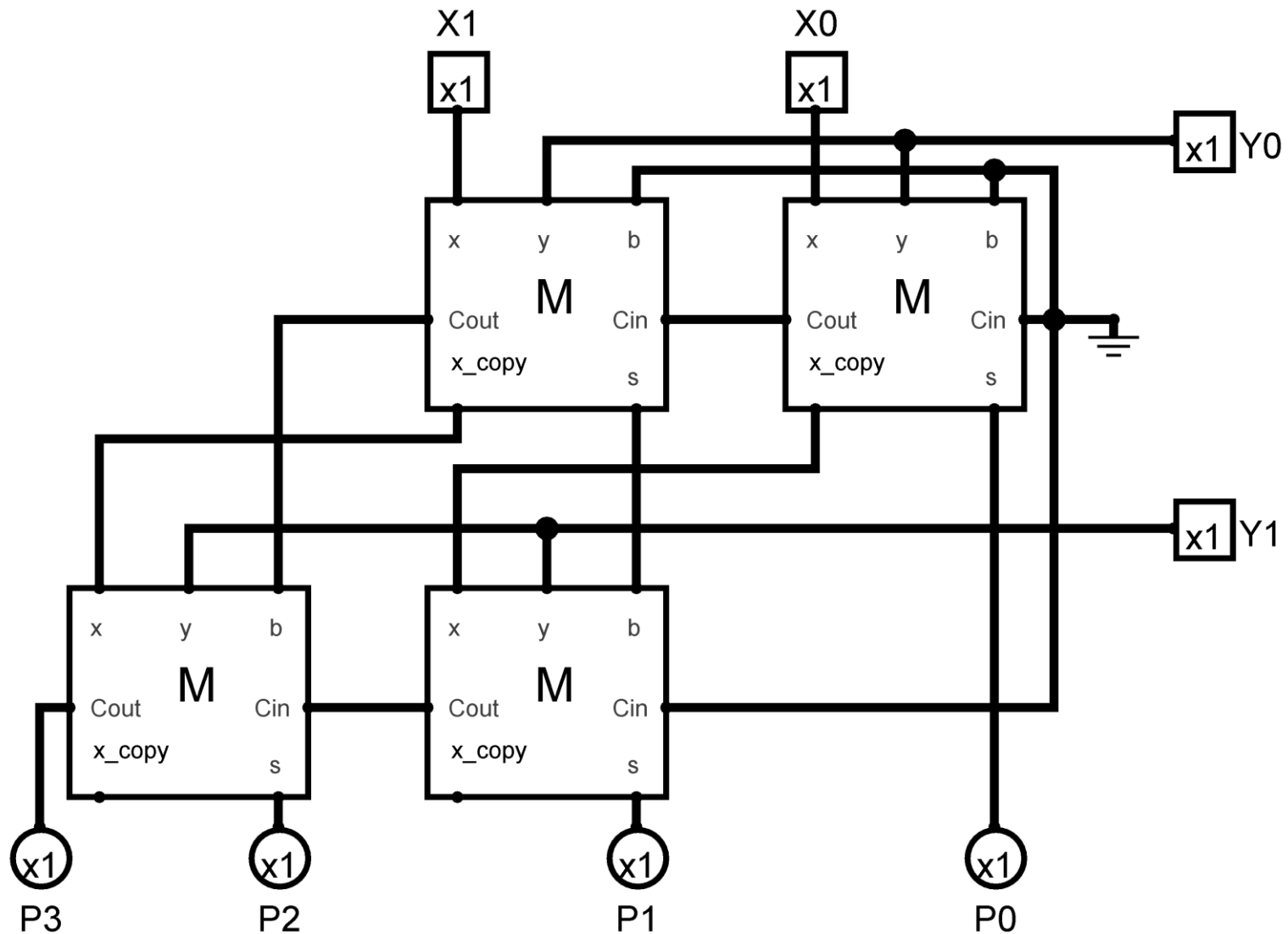


Figure: 2 \* 2 Unsigned Multiplier

# 2 \* 2 Unsigned Multiplier Simulation

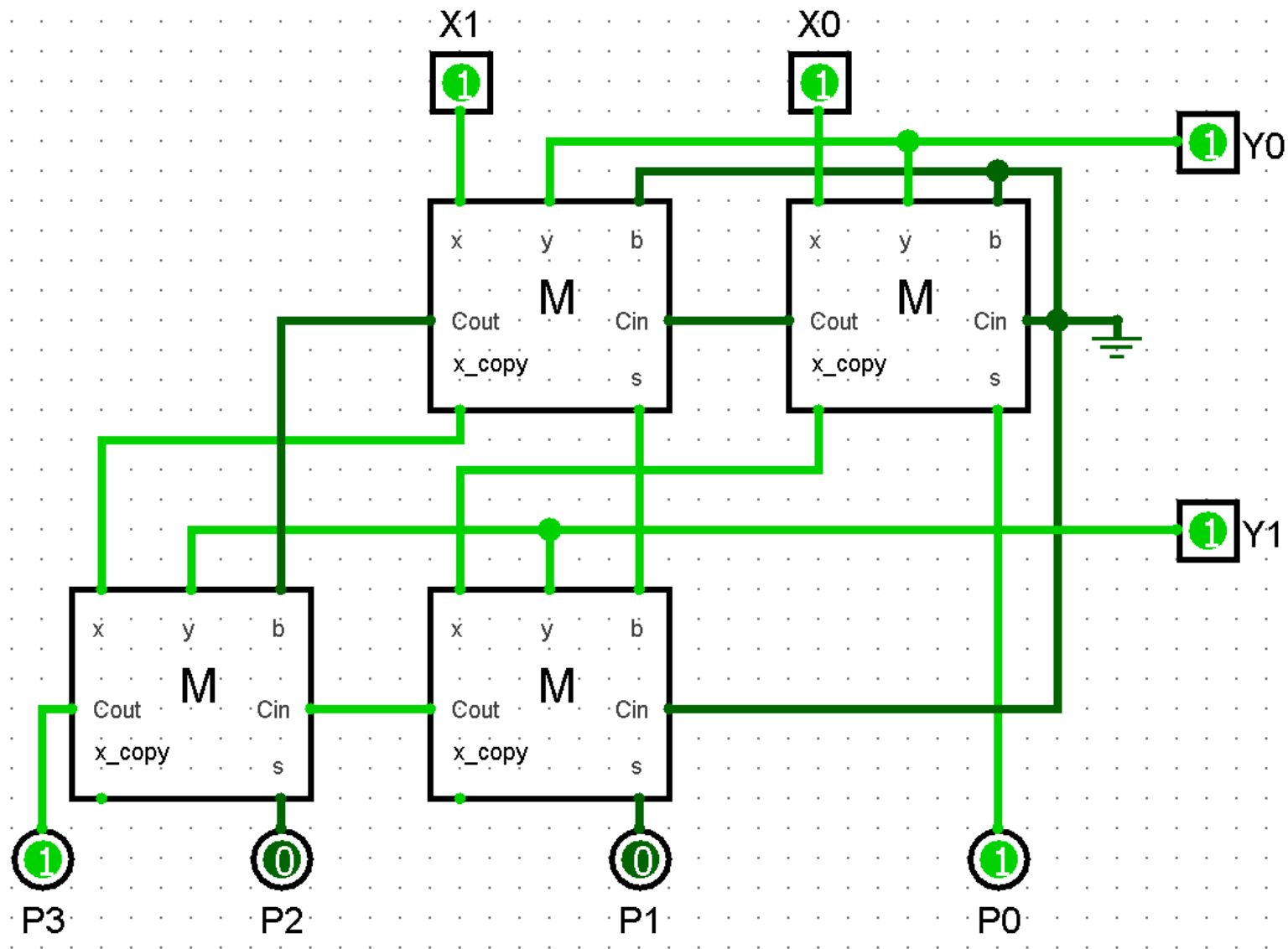
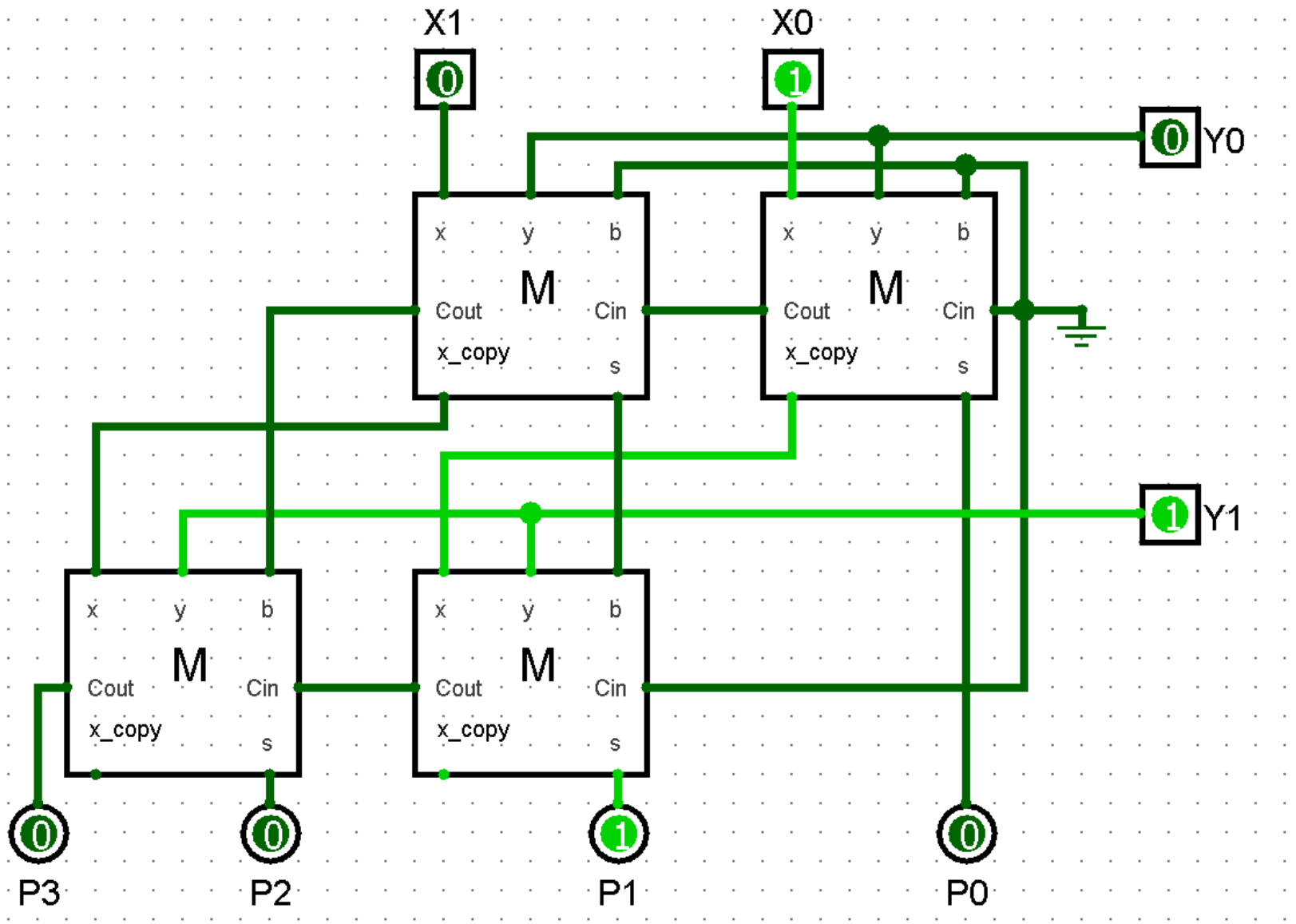


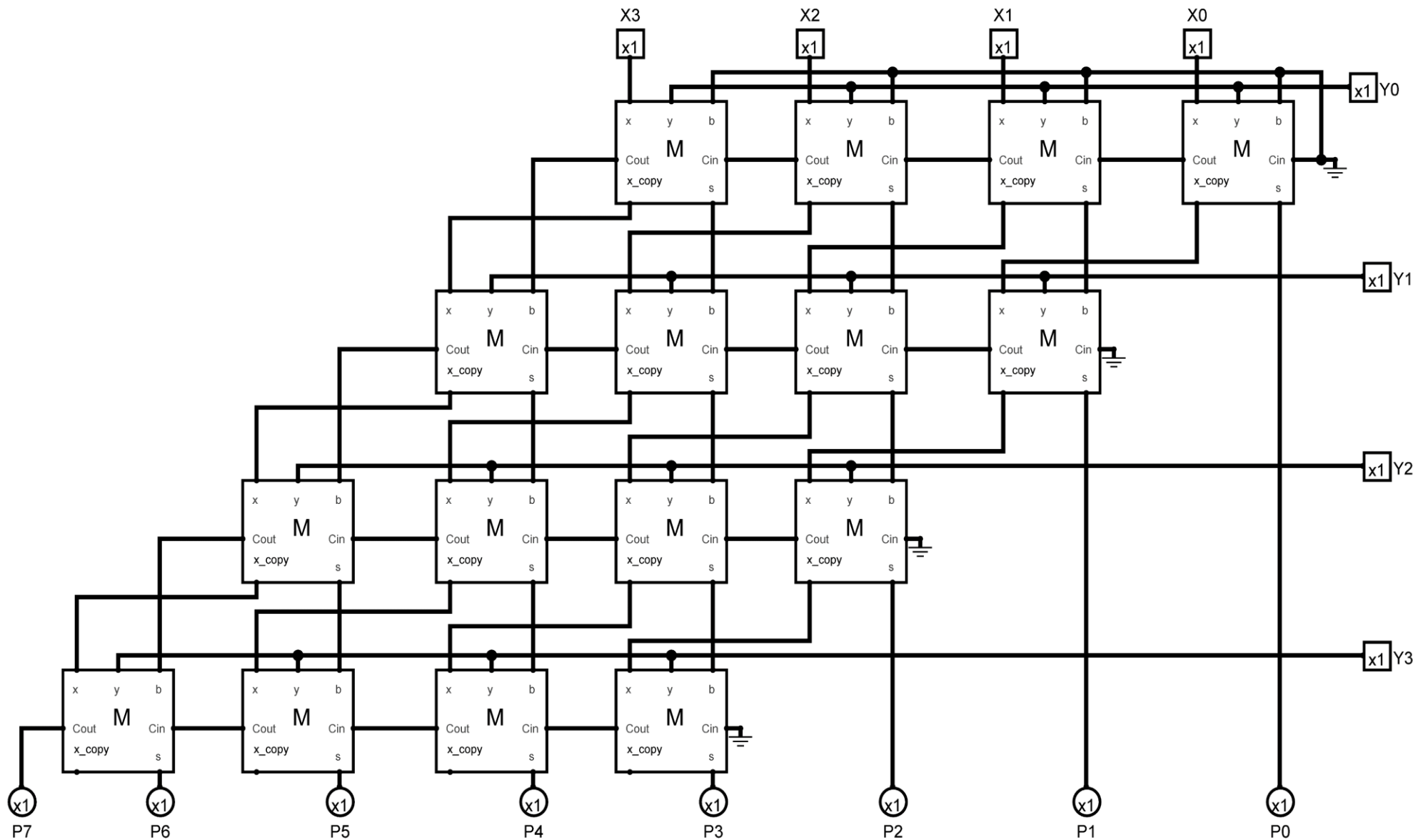
Figure: 2 \* 2 Unsigned Multiplier Simulation for input X = 11 and Y = 11

# 2 \* 2 Unsigned Multiplier Simulation



### Figure: 2 \* 2 Unsigned Multiplier Simulation for input X = 01 and Y = 10

# 4 \* 4 Unsigned Multiplier



### Figure: 4 \*4 Unsigned Multiplier



# 4 \* 4 Unsigned Multiplier Simulation

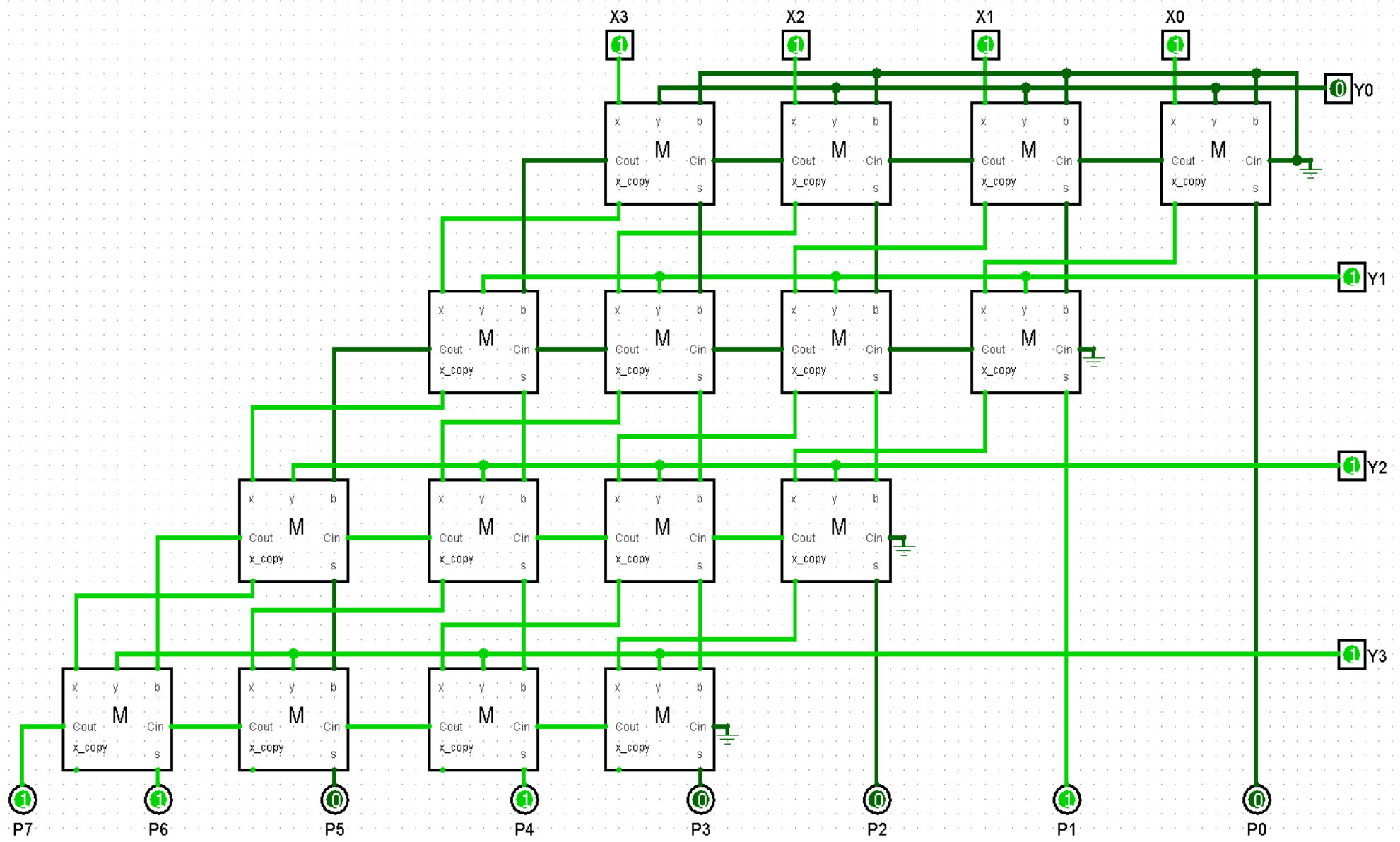


Figure: 4 \* 4 Unsigned Multiplier Simulation for X = 1111 and Y = 1110

# 4 \* 4 Unsigned Multiplier Simulation

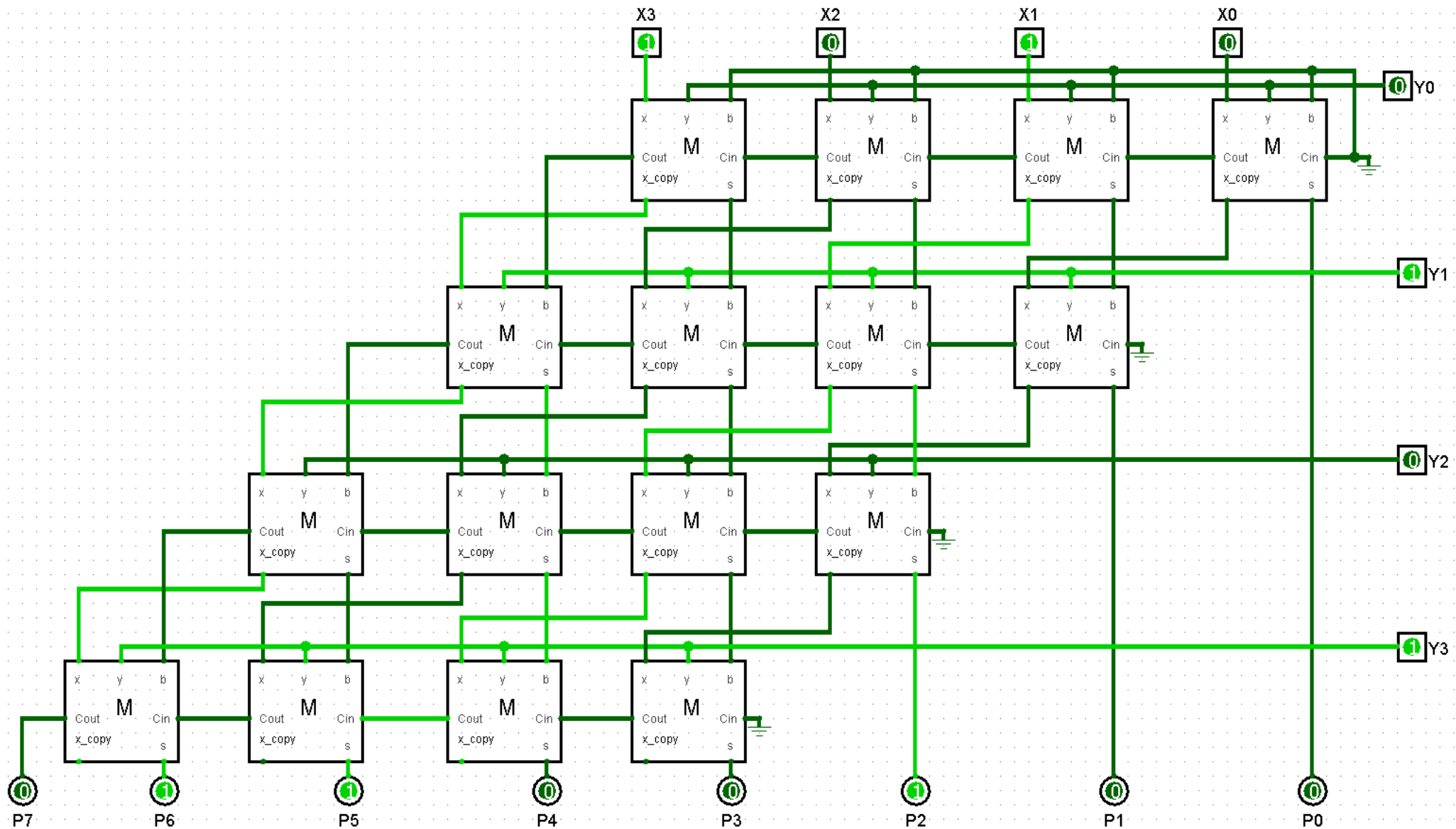


Figure: 4 \* 4 Unsigned Multiplier Simulation for X = 1010 and Y = 1010

# Exercises

1. Multiply  $1001 * 1010$  and design a circuit which can calculate this.
2. How does your computer do multiplication in program statement,  
 $Z = X * Y$  or  $Z = 1001 * 1010$  (both are unsigned).  
Design a circuit and show how it calculates the result in each component.
3. Design a 2/3/4 bit unsigned multiplier and  
show output of each circuit in when  $X = 10$  or  $111$  or  $1001$  and  $Y = 11$  or  $100$  or  $1111$ .