Unsigned Binary Divider

Nahin Ul Sadad
Lecturer,
CSE, RUET

Unsigned Division Example

Example: 1111 ÷ 0111
Here, Dividend, A = 1111 (15)
Divisor, B = 0111 (7)

```
0111 ) 1111 ( 0010
       - 0
       ----------
         11          Here, Subtraction is unsigned subtraction.
       - 00
       ----------
         111
       - 111
       ----------
         0001
       - 0000
       ----------
          0001
```

Quotient = 0010 (2)
Remainder = 0001 (1)

Unsigned Division Example

Example: 1111 ÷ 0111
Here, Dividend, A = 1111 (15)
Divisor, B = 0111 (7)

If we slightly change its way of calculation, then

```
0111 ) 0001111 ( 0010
       - 0000
       ----------------
          0011
        - 0000
       ----------------
           0111
         - 0111
       ------------------
             0001
           - 0000
       --------------------
             0001
```

Quotient = 0010 (2)
Remainder = 0001 (1)

Unsigned Division Example

Table: Example of Unsigned Division
A = 1111 (4-bit) and **B =** 0111 (4-bit)
So, **Q =** 0010 (4-bit) and **R** = 0001(4-bit)

Extend A = 0001011 (7-bit)

Step	A	PA (Partial A)	B	PA-B	Borrow Out	Q	Operation	New PA
1	0001111	0001111 0001111	0111	1010	1	0	PA = PA Right Shift PA	0001111
2	0001111	0001111 0001111	0111	1100	1	0	PA = PA Right Shift PA	0001111
3	0001111	0001111 0000001	0111	0000	0	1	PA = PA-B Right Shift PA	0000001
4	0001111	0000001	0111	1010	1	0	PA = PA	0000001 Remainder

Unsigned Divider Building Block (Cell D)

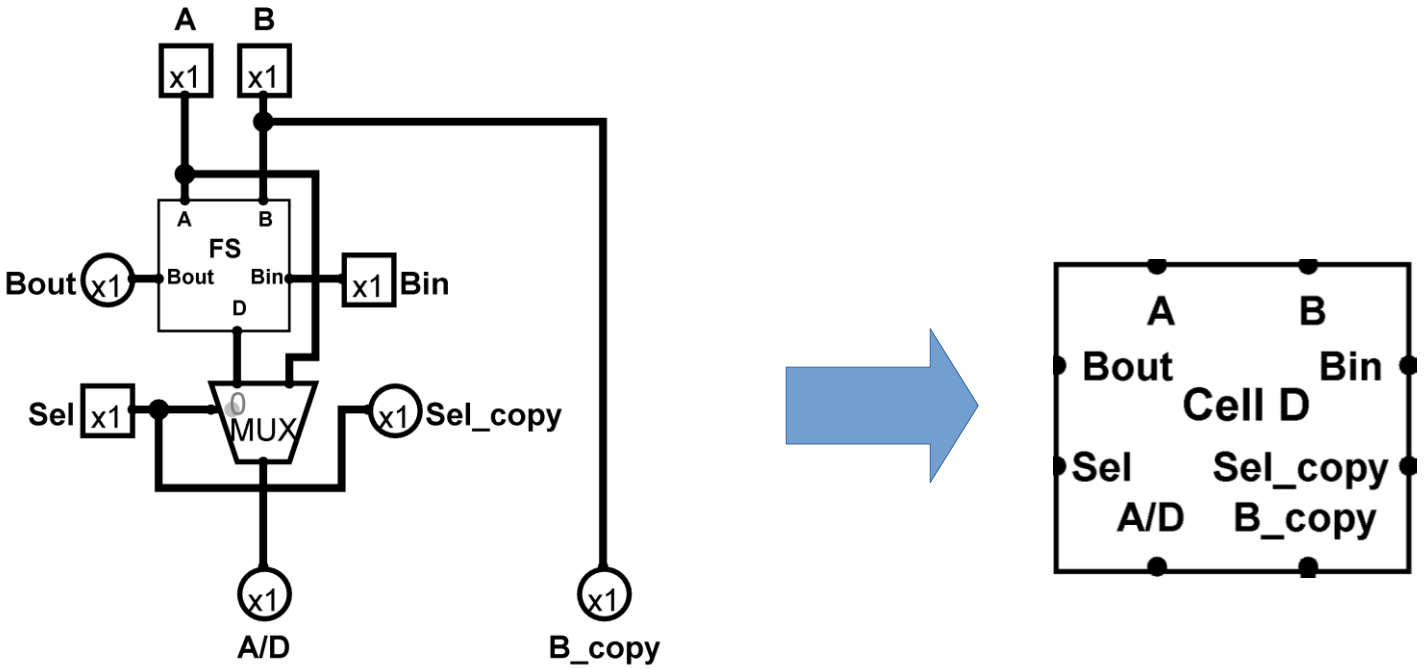

Figure: Cell D (Building Block)

Here,

1. **FS is the Full Subtractor.**
2. **MUX is 1bit 2 to 1 Multiplexer which will select between A and D.**
3. **Value of B and Sel will propagate to next Block which means they are also outputs.**

We are going to use a building block (Cell D) to create Unsigned Divider.

Unsigned Divider Building Block (FS)

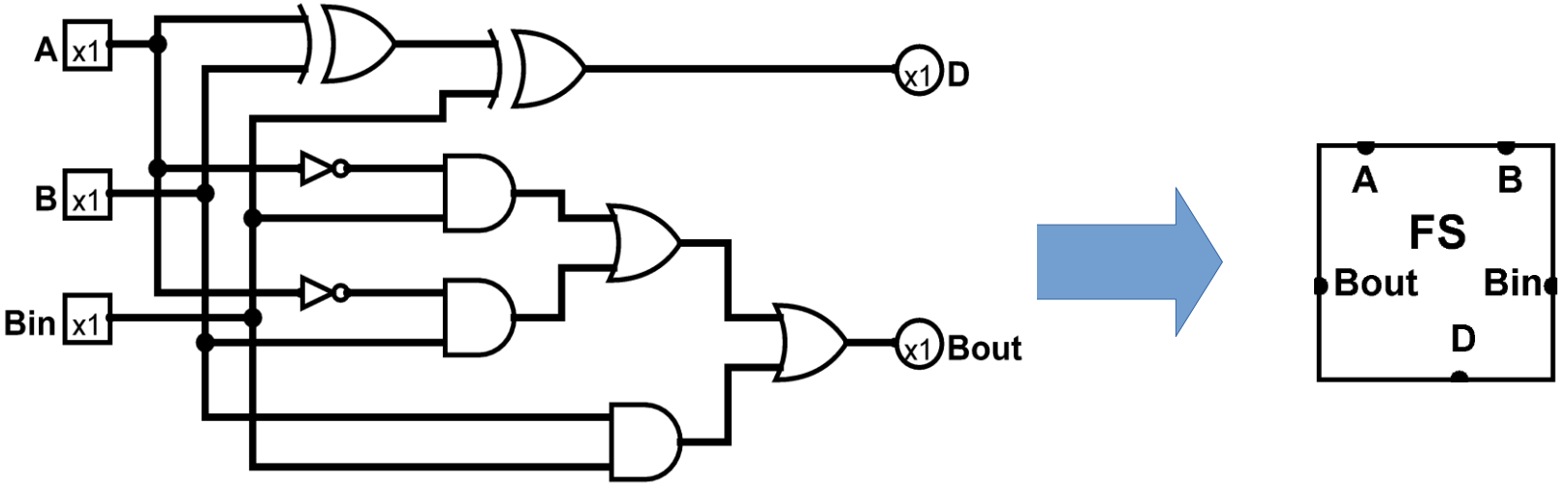

Figure: FS (Full Subtractor)

$$D = A \text{ XOR } B \text{ XOR } Bin$$

$$B_{out} = (\sim A \text{ AND } B) \text{ OR } (\sim A \text{ AND } Bin) \text{ OR } (B \text{ AND } Bin)$$

Here, `a`, `b` and `Bin` (Borrow in) are inputs.
`Bout` (Borrow out) and `D` (Difference) are outputs

2-bit Unsigned Divider

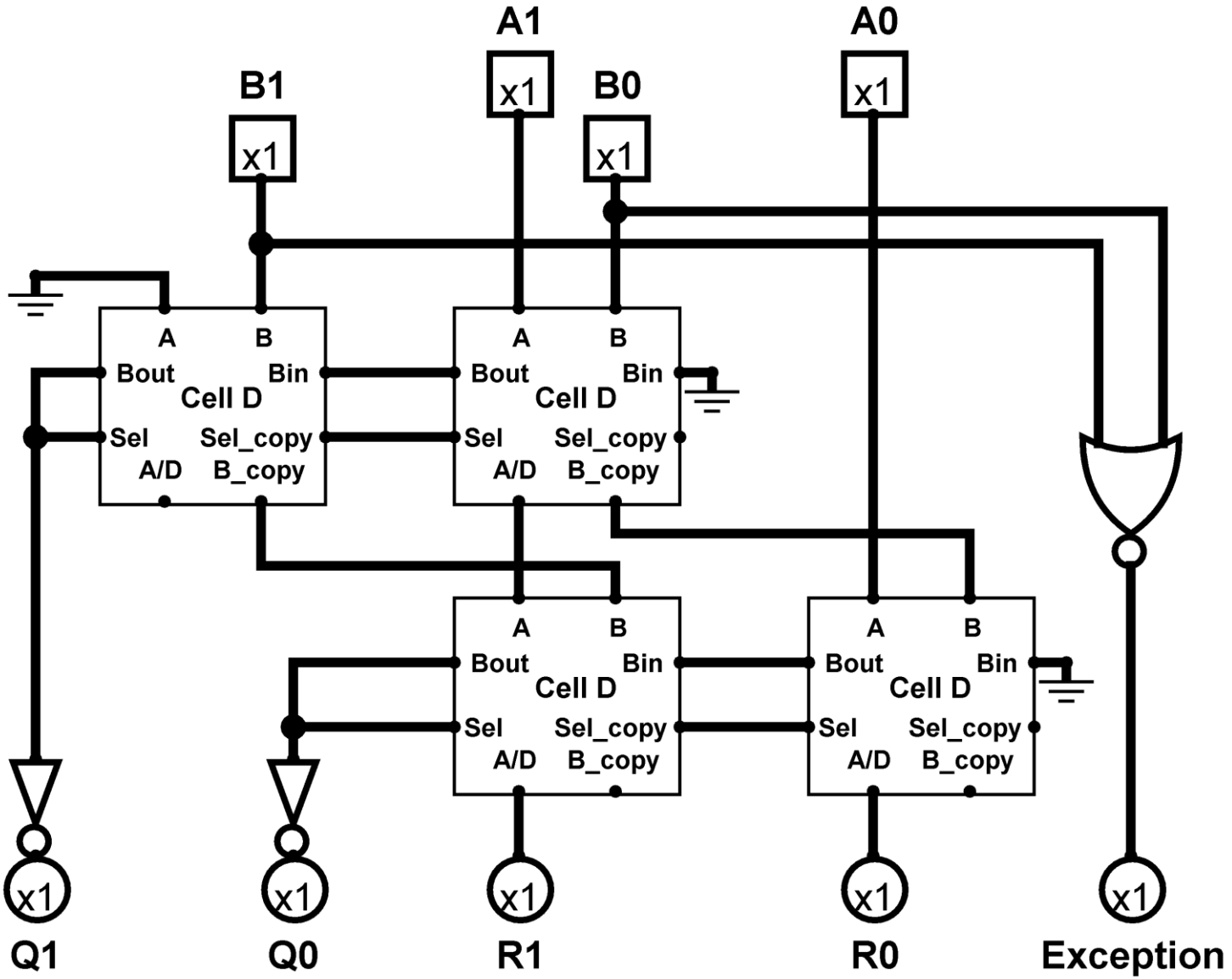

Figure: 2-bit Unsigned Divider

2-bit Unsigned Divider Simulation

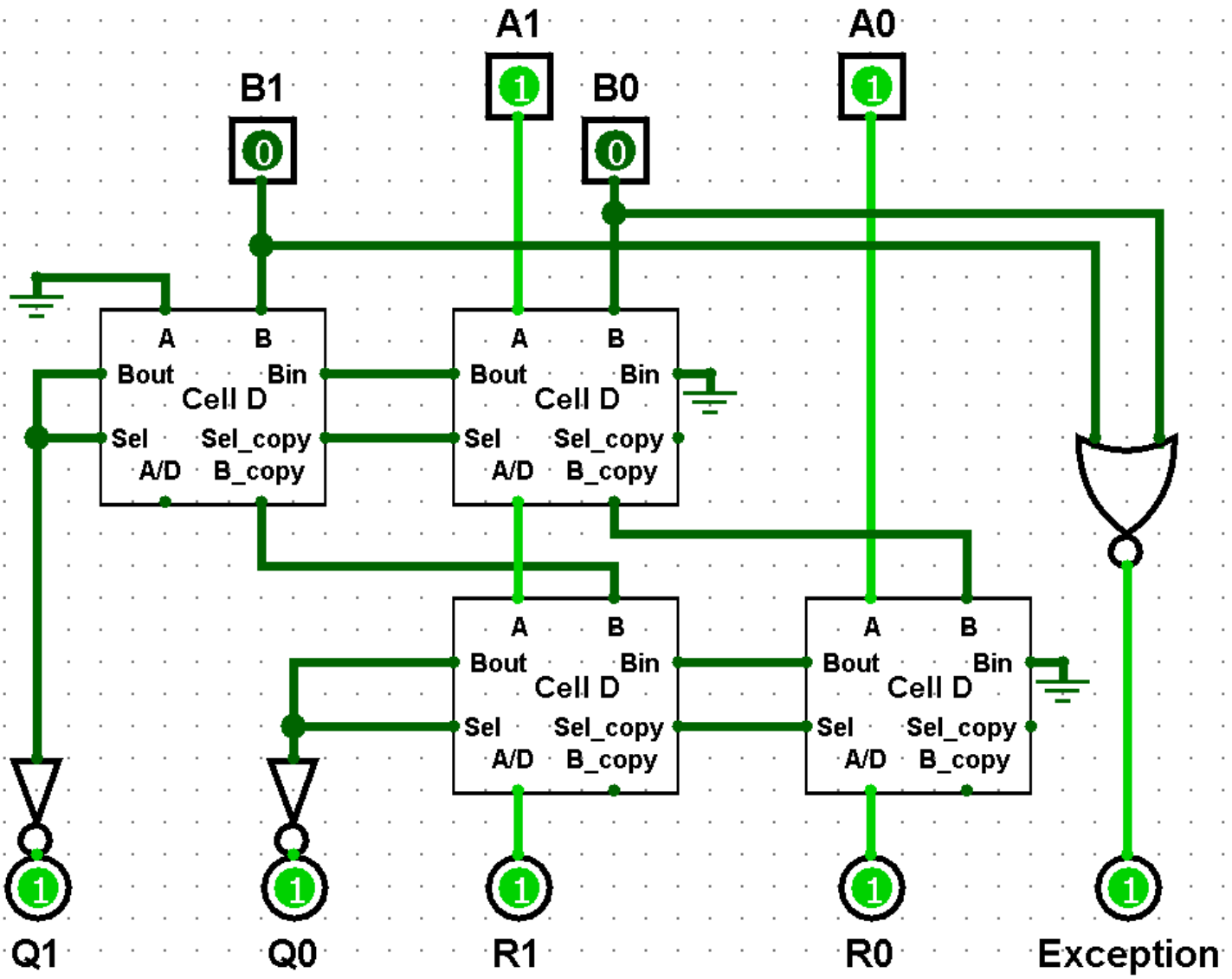

Figure: 2-bit Unsigned Divider Simulation for input A = 11 (3) and B = 00 (0). Output Q = XX, R = XX and Exception = 1. Because B = 0 and Division by 0 is not allowed.

2-bit Unsigned Divider Simulation

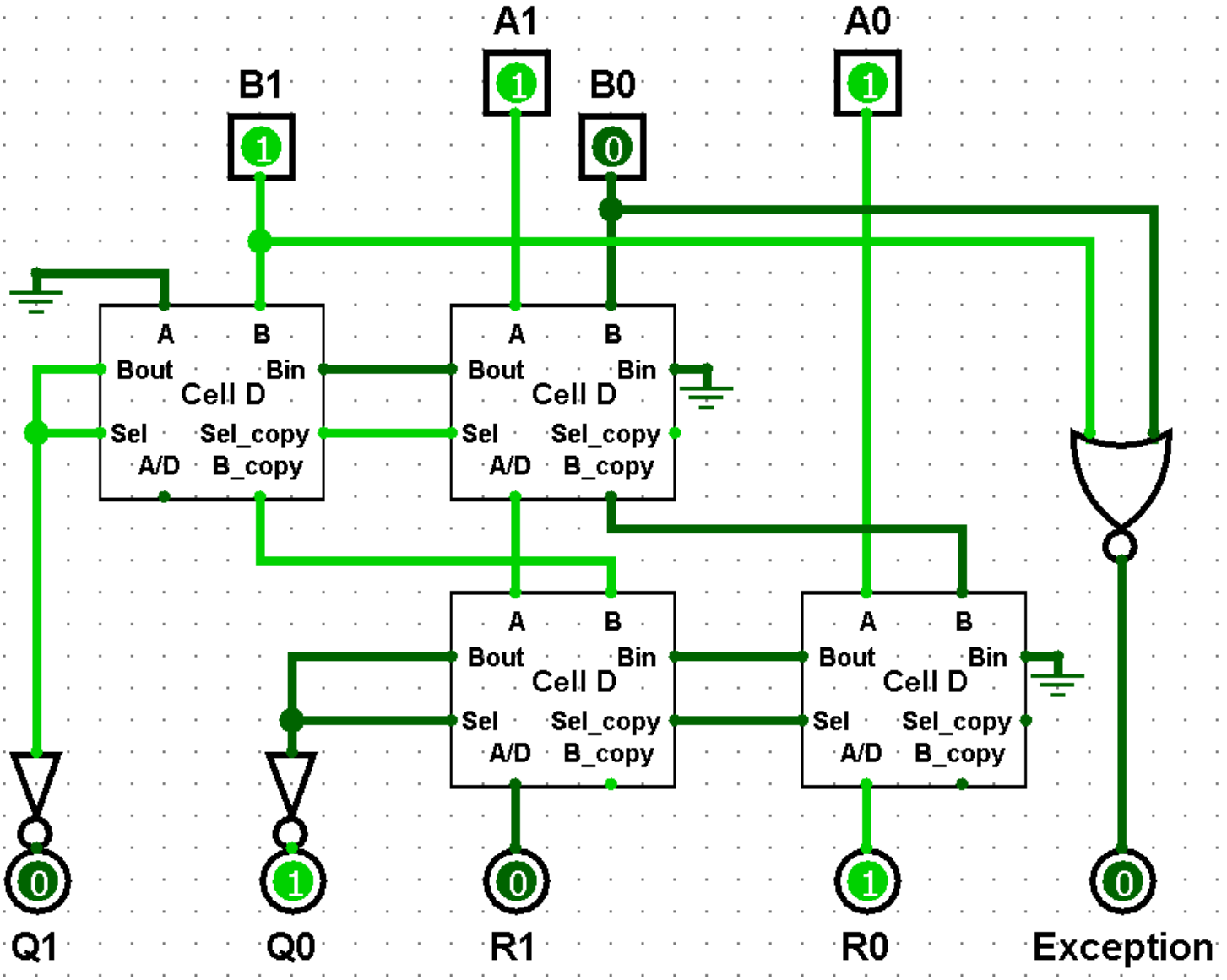

Figure: 2-bit Unsigned Divider Simulation for input A = 11 (3) and B = 10 (2). Output Q = 01 (1), R = 01 (1) and Exception = 1

4-bit Unsigned Divider

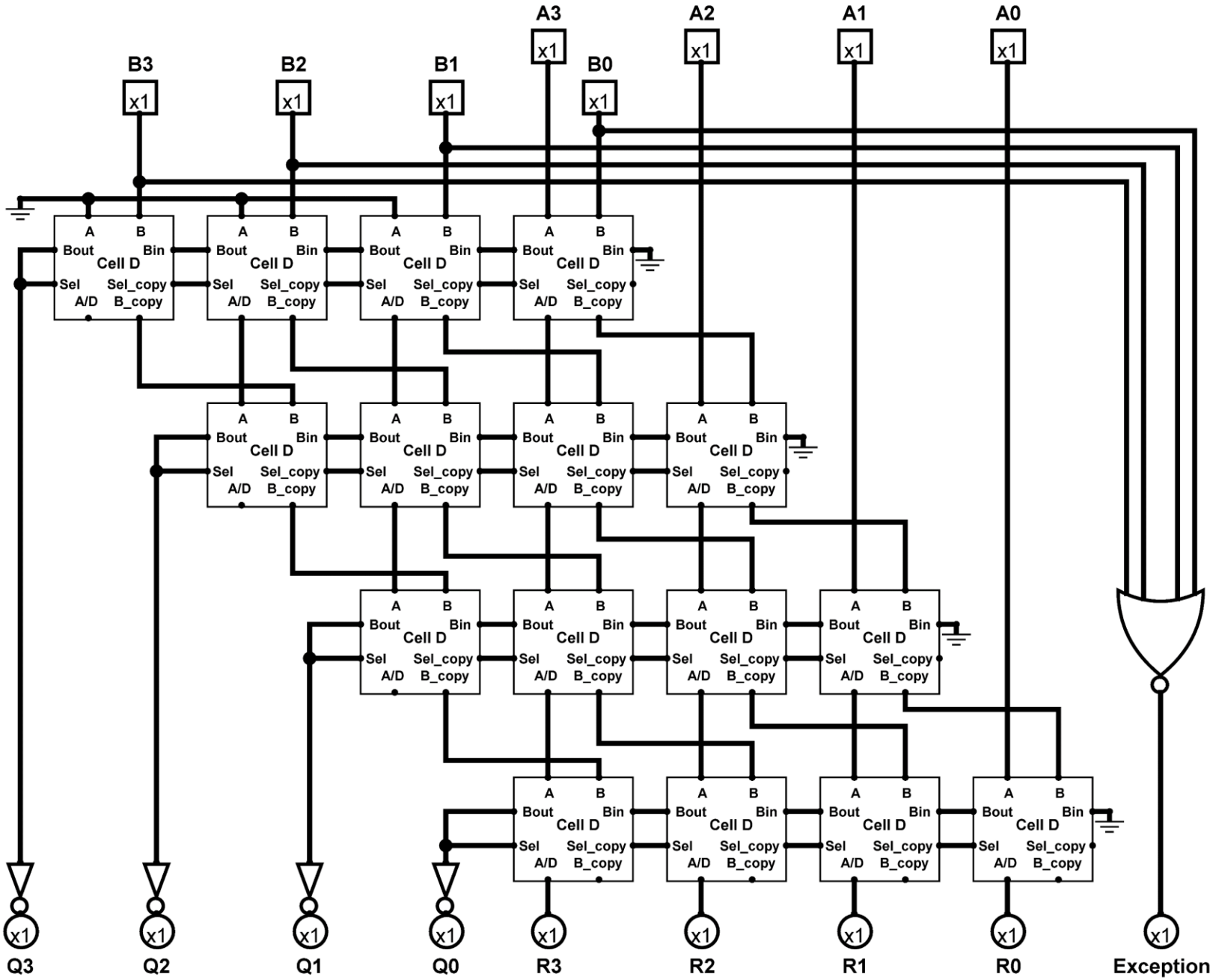

Figure: 4-bit Unsigned Divider

4-bit Unsigned Divider Simulation

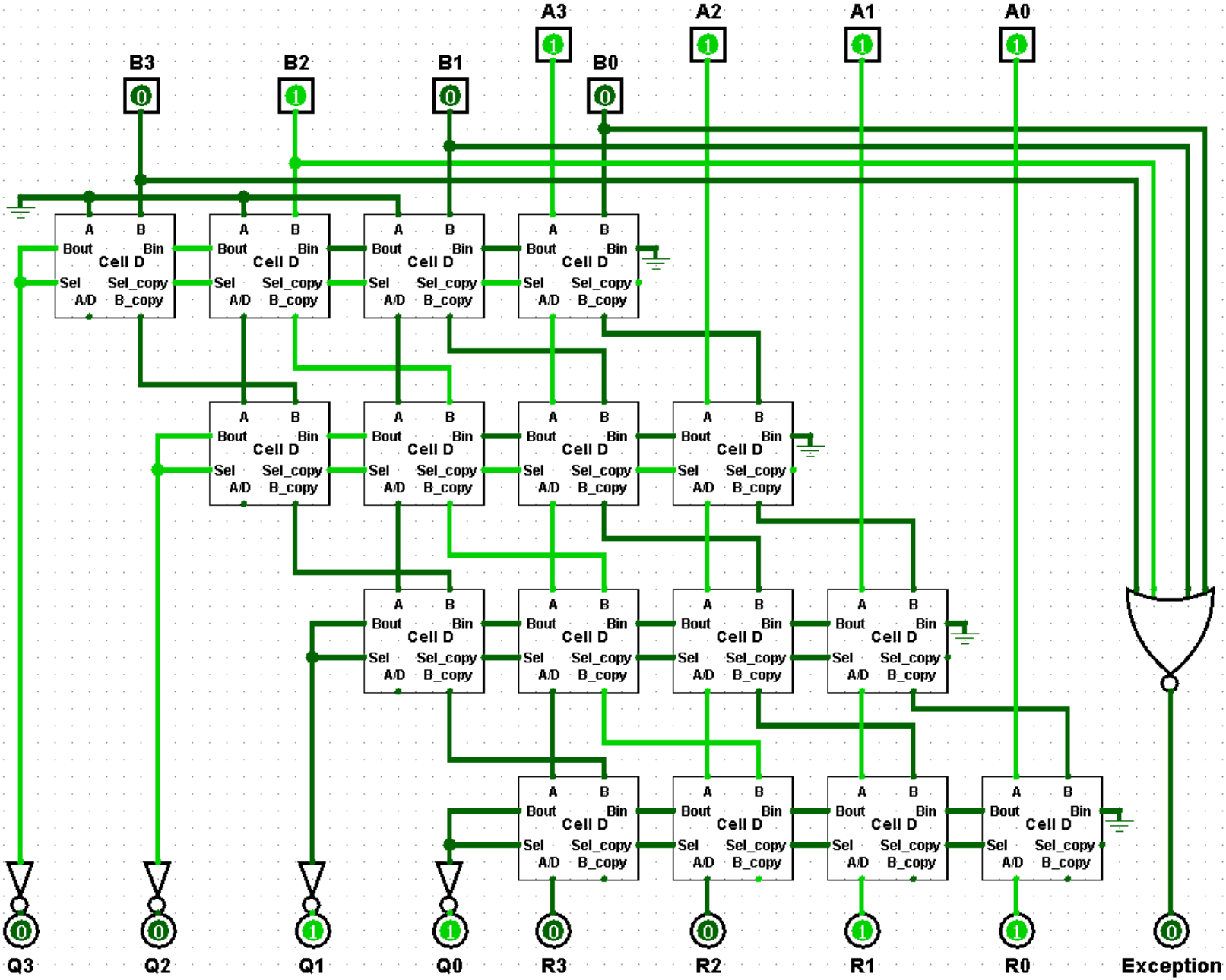

Figure: 4-bit Unsigned Divider Simulation for input A = 1111 (15) and B = 0100 (4). Output Q = 0011 (3), R = 0011 (3) and Exception = 0

4-bit Unsigned Divider Simulation

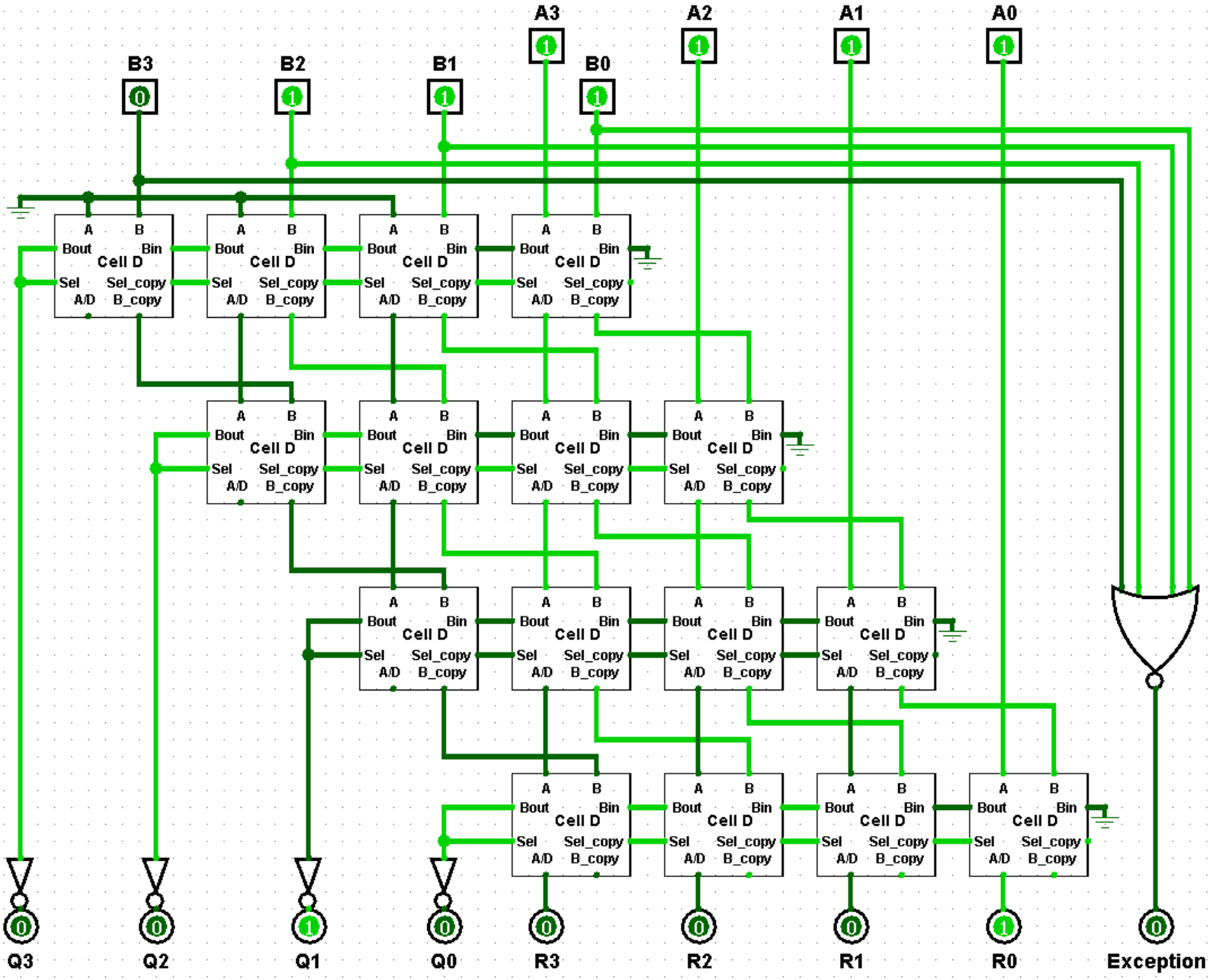

Figure: 4-bit Unsigned Divider Simulation for input A = 1111 (15) and B = 0111 (7). Output Q = 0010 (2), R = 0001 (1) and Exception = 0

Excercises

1. Divide 1010/0100 and design a circuit which can calculate this.

2. How does your computer do divide in program statement,
   Z = X / Y or Z = 1010 / 0100 (both are unsigned).
   Design a circuit and show how it calculates the result in each component.

3. Design a 2/3/4 bit unsigned divider and
   show output of each circuit in when X = 10 or 111 or 1001 and Y=11 or 100 or 1111.