Indian Institute of Technology Kharagpur

COA-22 Lab Assignment-1

Part 1:- Ripple Carry Adder

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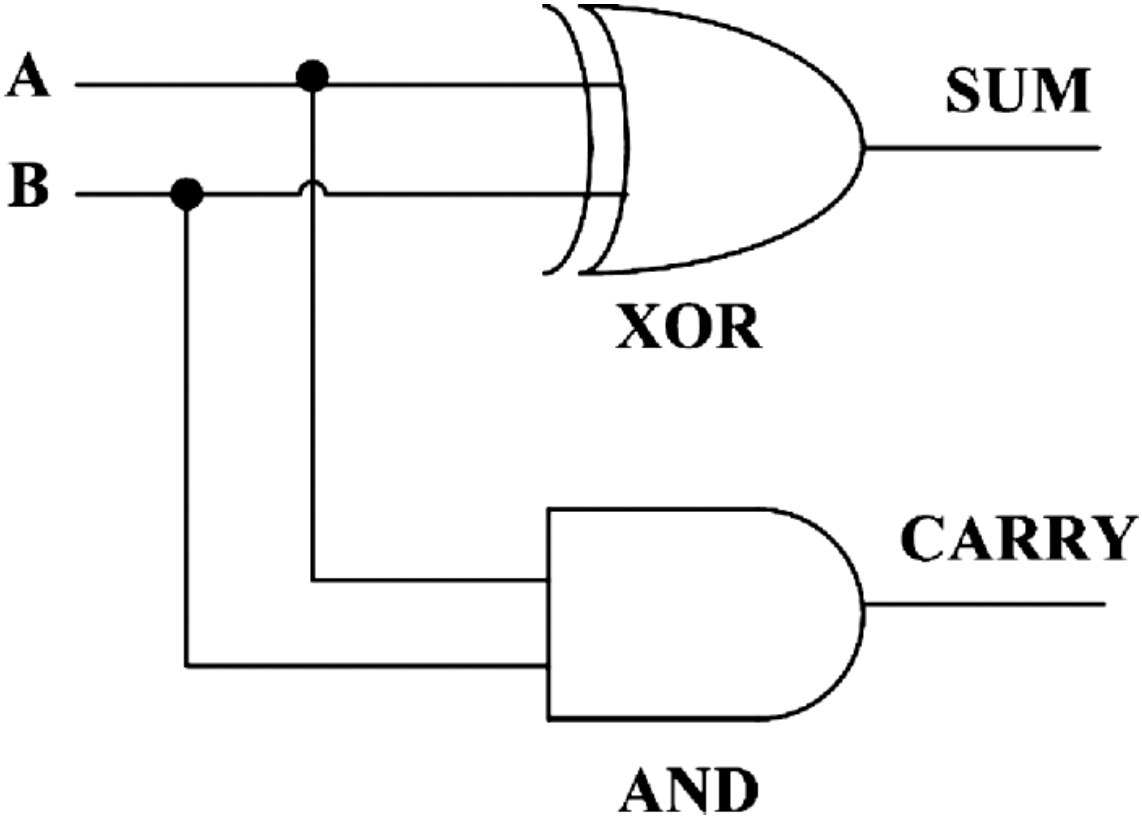
Contents

1 Half Adder

1.1 Circuit Diagram



1.2 Truth Table

(i)			
a	b	s	c
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

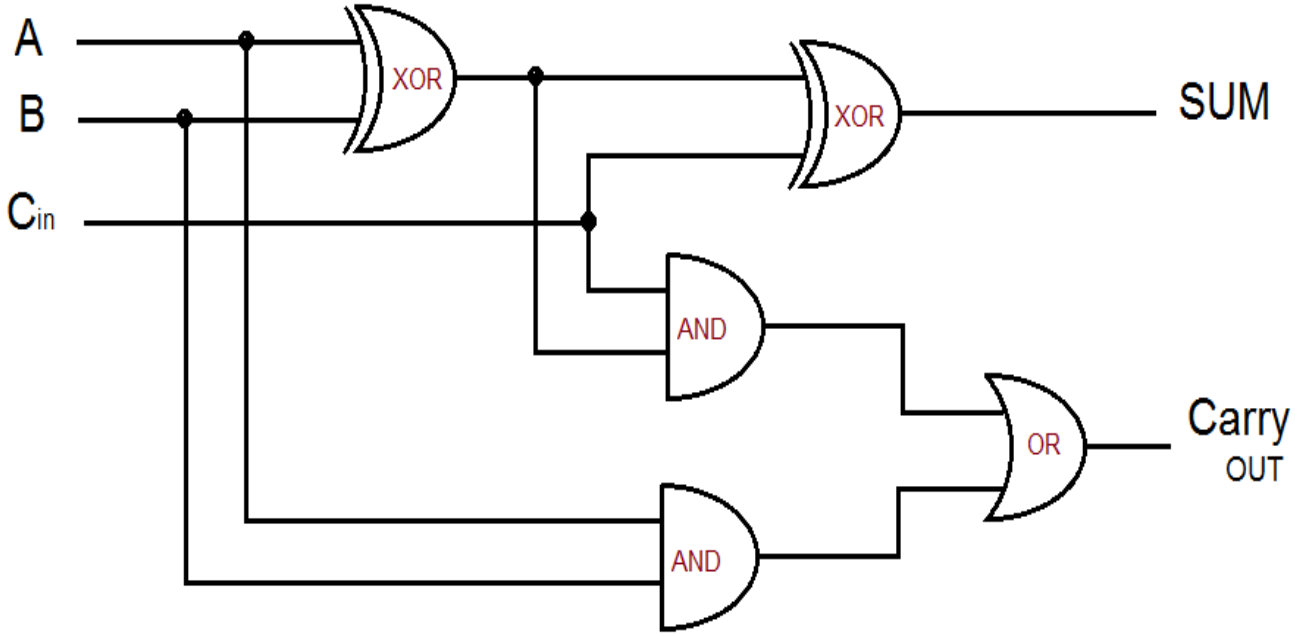
1.3 Logic Expression

$$s = a \oplus b \tag{1}$$

$$c = a \ \& \ b \tag{2}$$

2 Full Adder

2.1 Circuit Diagram



2.2 Truth Table

(ii)				
a	b	c_{in}	s	c_{out}
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
1	0	0	1	0
1	1	0	0	1
1	0	1	0	1
0	1	1	0	1
1	1	1	1	1

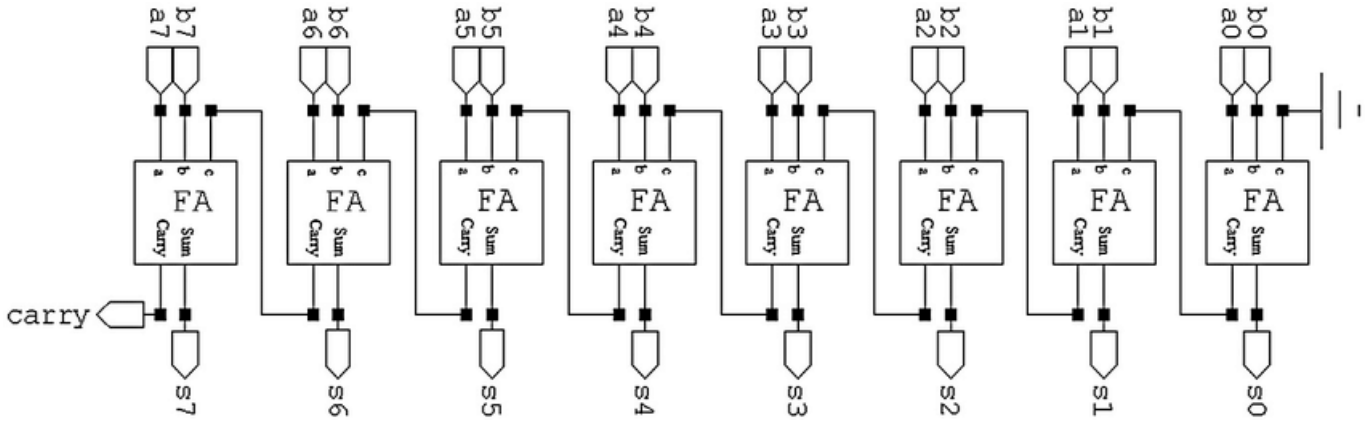
2.3 Logic Expression

$$s = a \oplus b \oplus c_{in} \tag{3}$$

$$c_{out} = (a \ \& \ b)|(c \ \& \ (a \oplus b) \tag{4}$$

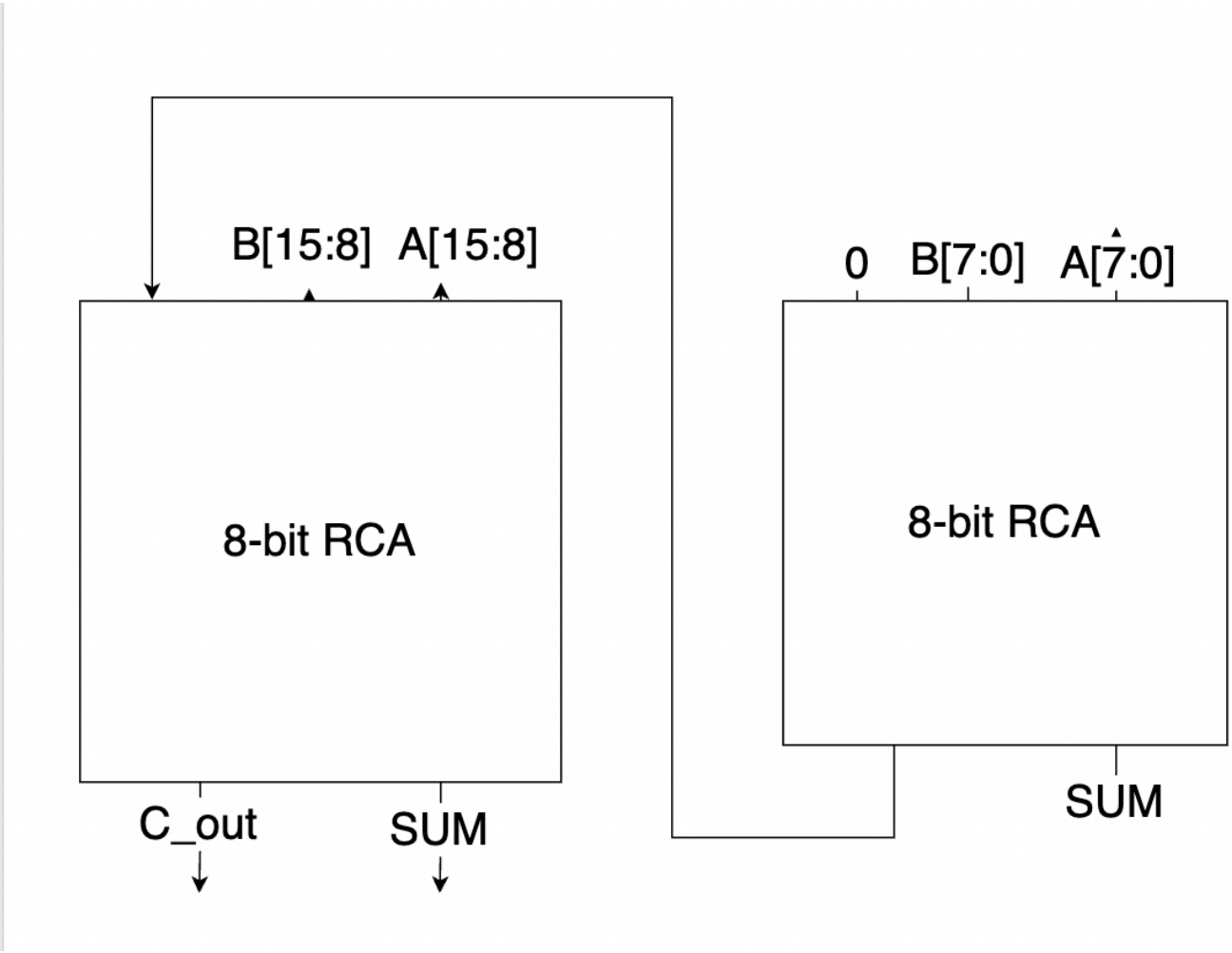
3 Ripple Carry Adder for 8-bit

3.1 Circuit Diagram



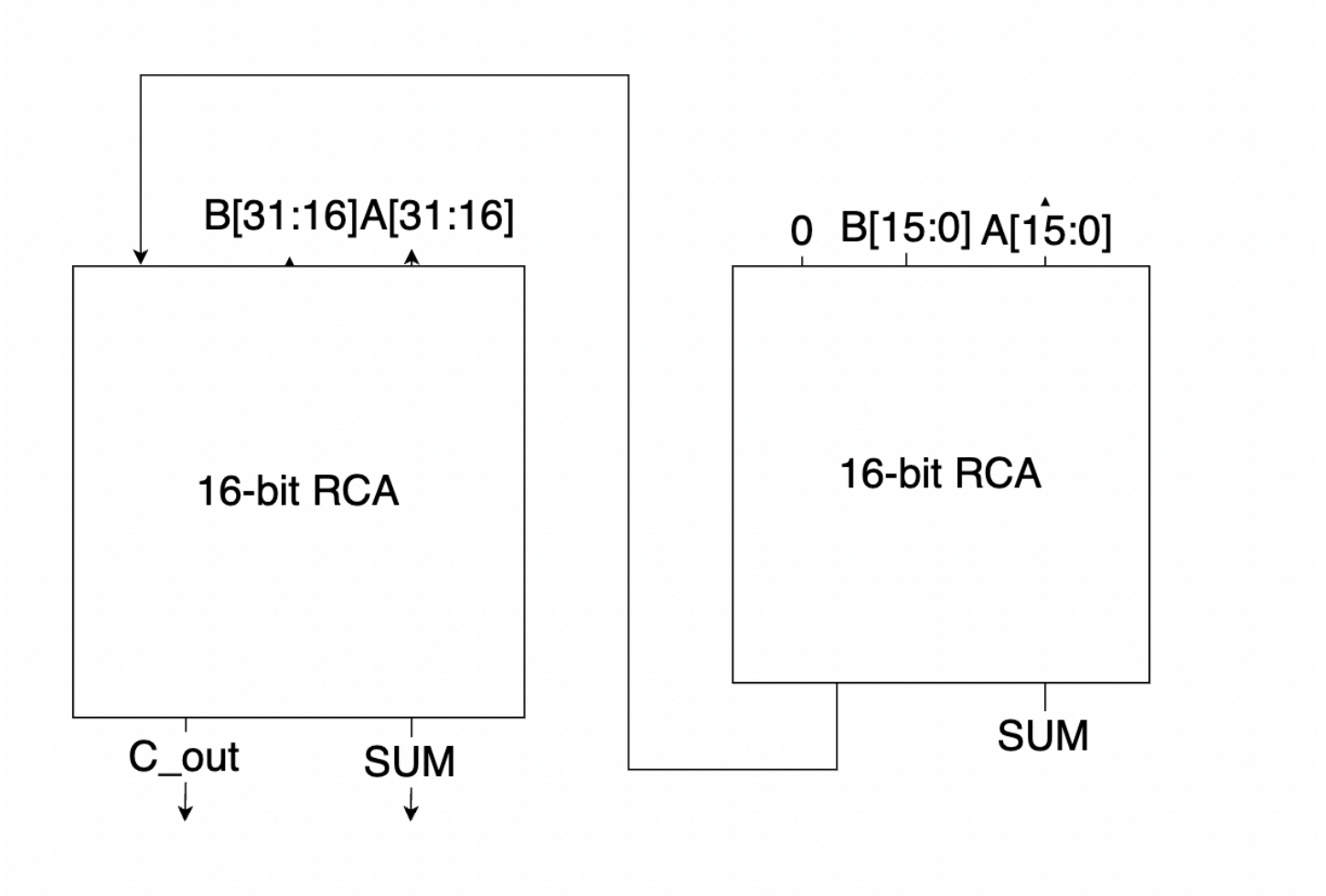
4 Ripple Carry Adder for 16-bit

4.1 Circuit Diagram



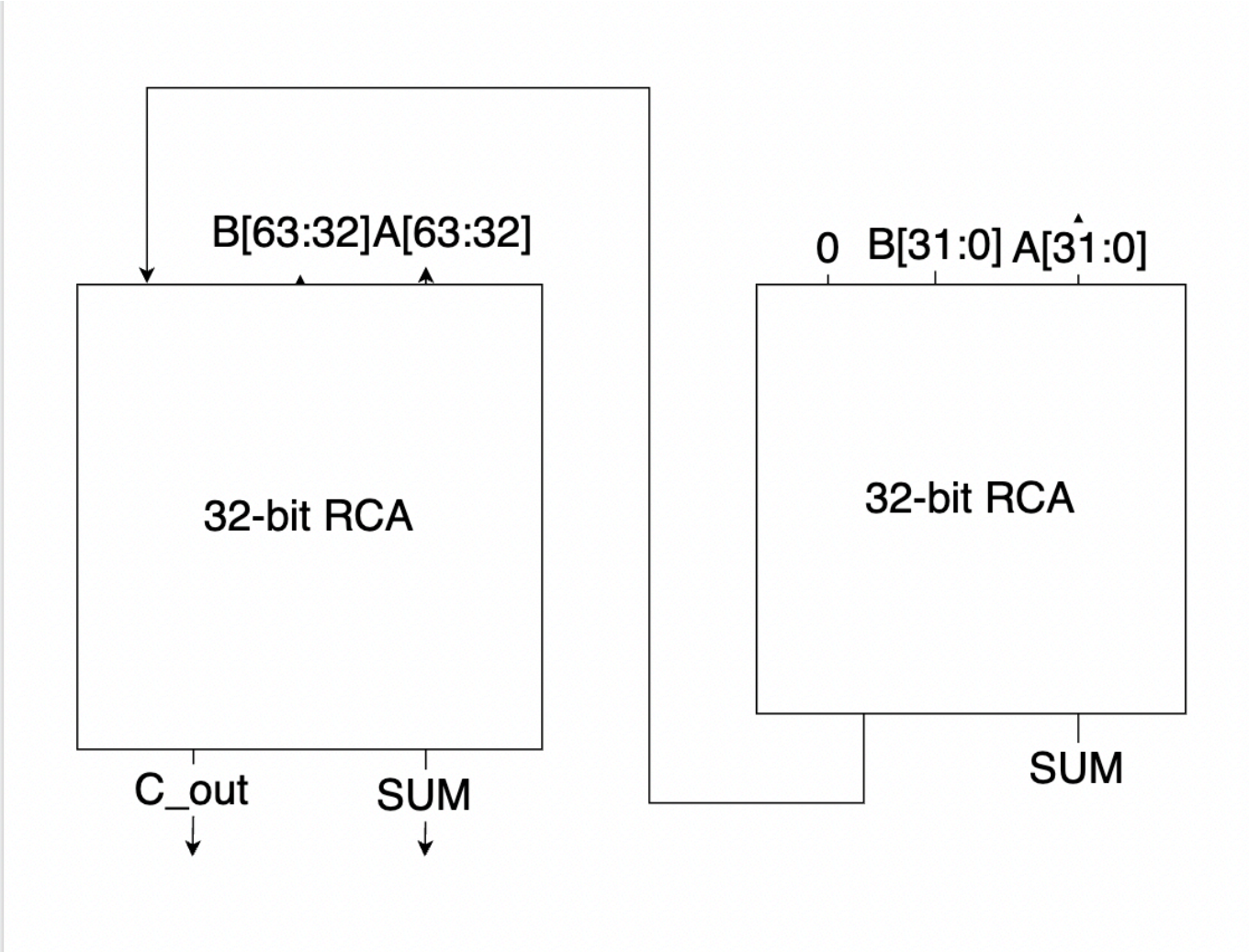
5 Ripple Carry Adder for 32-bit

5.1 Circuit Diagram



6 Ripple Carry Adder for 64-bit

6.1 Circuit Diagram



7 Synthesis Table

7.1 Table

Design Summary		
Delay	Slice LUT's	Bonded IOB's
2.523 ns	12	26
4.467 ns	24	50
8.356 ns	48	98
16.134 ns	96	194

8 Difference of two n-bit Numbers

8.0.1 How can you use the above circuit, to compute the difference between two n-bit numbers?

We have constructed 8-bit, 16-bit, 32-bit, 64-bit Ripple Carry Adder using Half-Adders and Full-Adders Circuit.

We see for n-bit numbers p and q, the difference between them can be written as,

$$p - q = p + (-q) \tag{5}$$

We observe that (-b) is the two's complement of b:-

$$-b = \sim b + 1 \tag{6}$$

So,

$$a - b = rca_n(a, \sim b, 1) \tag{7}$$

Wherein,

a = First Number

b = Second Number

carry-in = 1

To obtain the difference, we may use the 64-bit RCA Adder and enter an as the first number and b as the second number (negative number), which will be saved in the 2's complement form of b.

The second method we may make a difference is as follows: A switch connected to the adder's carry-in, as well as XOR gates connected to each of the input bits for bit b, may be added to the circuit. When the switch is turned on, the carry-in is set to 1 and all of the bits of b are flipped at the same time (xor with 1 flip all bits). This will get the result a-b. If the switch is flipped, the output will be a+b.