Ripple Carry Adder (1A)

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Please send corrections (or suggestions) to youngwlim@hotmail.com.

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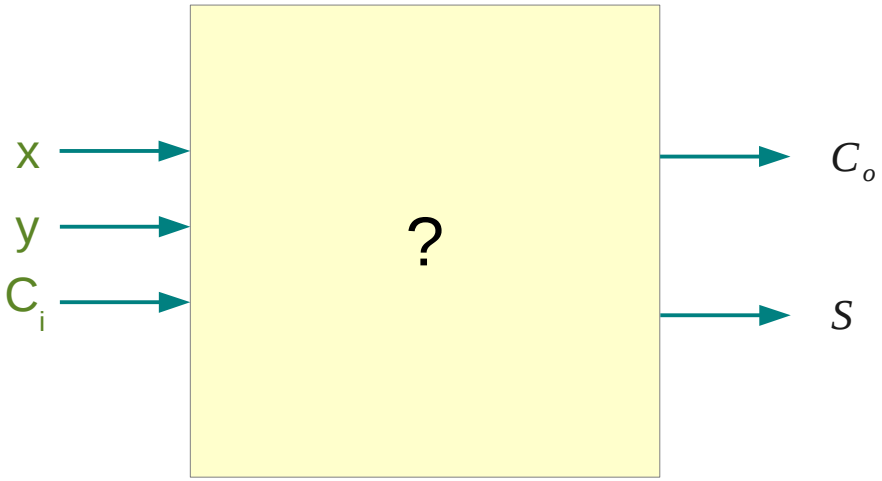
Truth Table

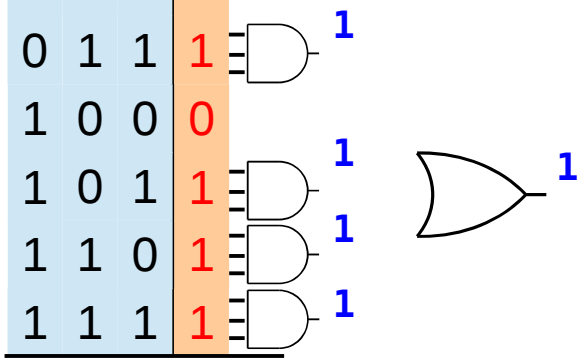
x	y	C_i	C_o	S
0	0	0	0	0
0	0	1	0	1
0	1	0	0	1
0	1	1	1	0
1	0	0	0	1
1	0	1	1	0
1	1	0	1	0
1	1	1	1	1

inputs output

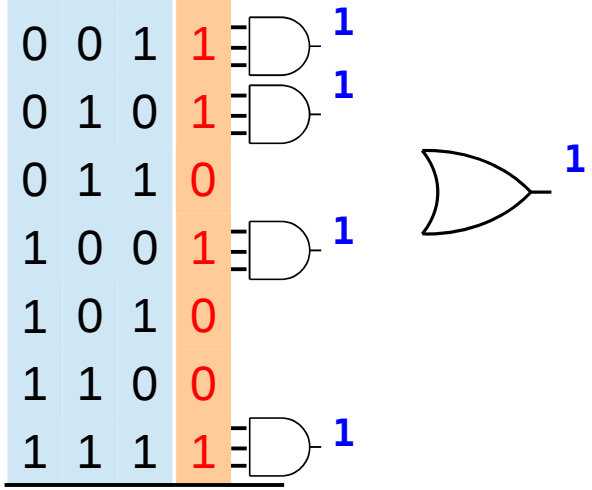


SOP

x	y	C_i	C_o
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1



x	y	C_i	S
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	0
1	1	0	0
1	1	1	1

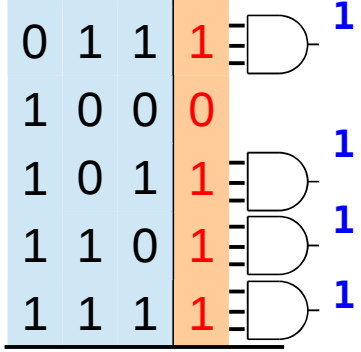


$$C_o = \bar{x}\,y\,C_i + x\,\bar{y}\,C_i + x\,y\,\bar{C}_i + x\,y\,C_i$$

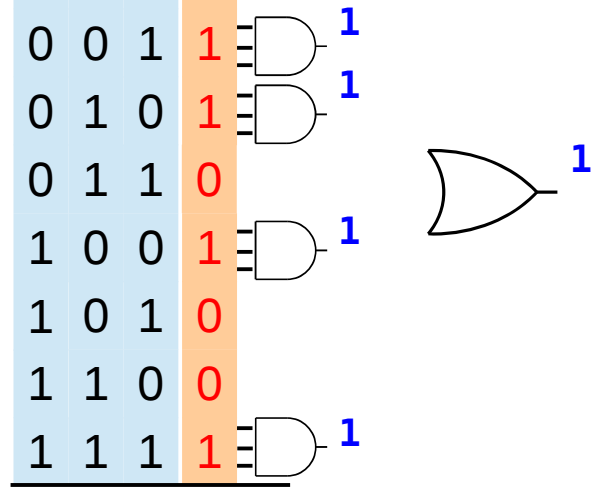
$$S = \bar{x}\,\bar{y}\,C_i + \bar{x}\,y\,\bar{C}_i + x\,\bar{y}\,\bar{C}_i + x\,y\,C_i$$

K-Map

x	y	C_i	C_o
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

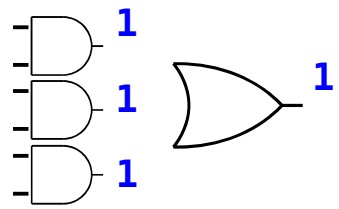


x	y	C_i	S
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	0
1	1	0	0
1	1	1	1



x \ y	0	1
0	0	1
1	1	1

C_i



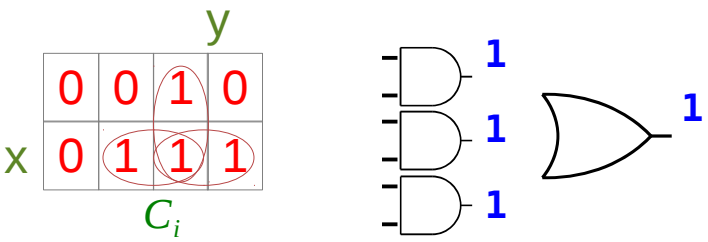
x \ y	0	1
0	0	1
1	1	0

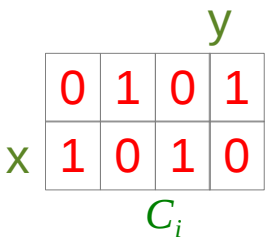
C_i

$$C_o = y C_i + x C_i + x y$$

$$S = \bar{x}\,\bar{y}\,C_i + \bar{x}\,y\,\bar{C}_i + x\,\bar{y}\,\bar{C}_i + x\,y\,C_i$$

Boolean Algebra





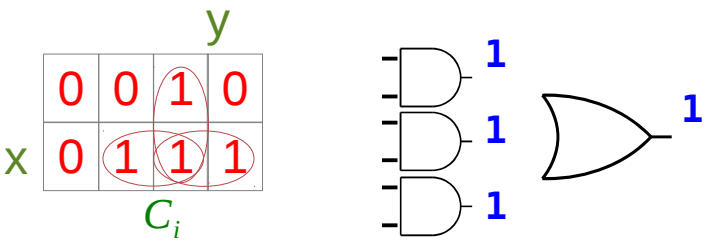
$$C_o = y C_i + x C_i + x y$$

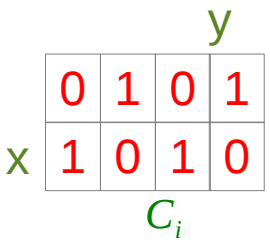
$$\begin{aligned} C_o &= (x + y) C_i + x y \\ &= (\bar{x} y + x \bar{y} + xy) C_i + x y \\ &= (\bar{x} y + x \bar{y}) C_i + xy (C_i + 1) \\ &= (x \oplus y) C_i + xy \end{aligned}$$

$$S = \bar{x}\,\bar{y}\,C_i + \bar{x}\,y\,\bar{C}_i + x\,\bar{y}\,\bar{C}_i + x\,y\,C_i$$

$$\begin{aligned} S &= (\bar{x}\,\bar{y} + xy) C_i + (\bar{x}\,y + x\,\bar{y}) \bar{C}_i \\ &= \overline{(x \oplus y)} C_i + (x \oplus y) \bar{C}_i \\ &= (x \oplus y) \oplus C_i \end{aligned}$$

Boolean Algebra



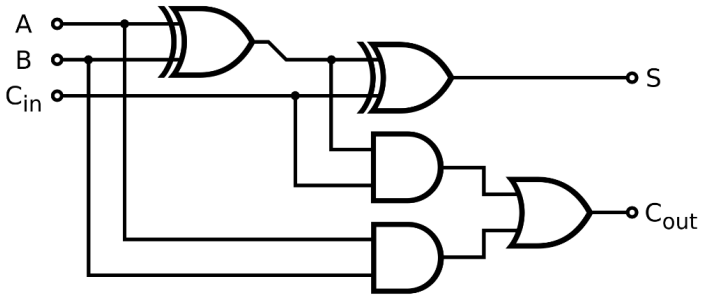


$$C_o = y C_i + x C_i + x y$$

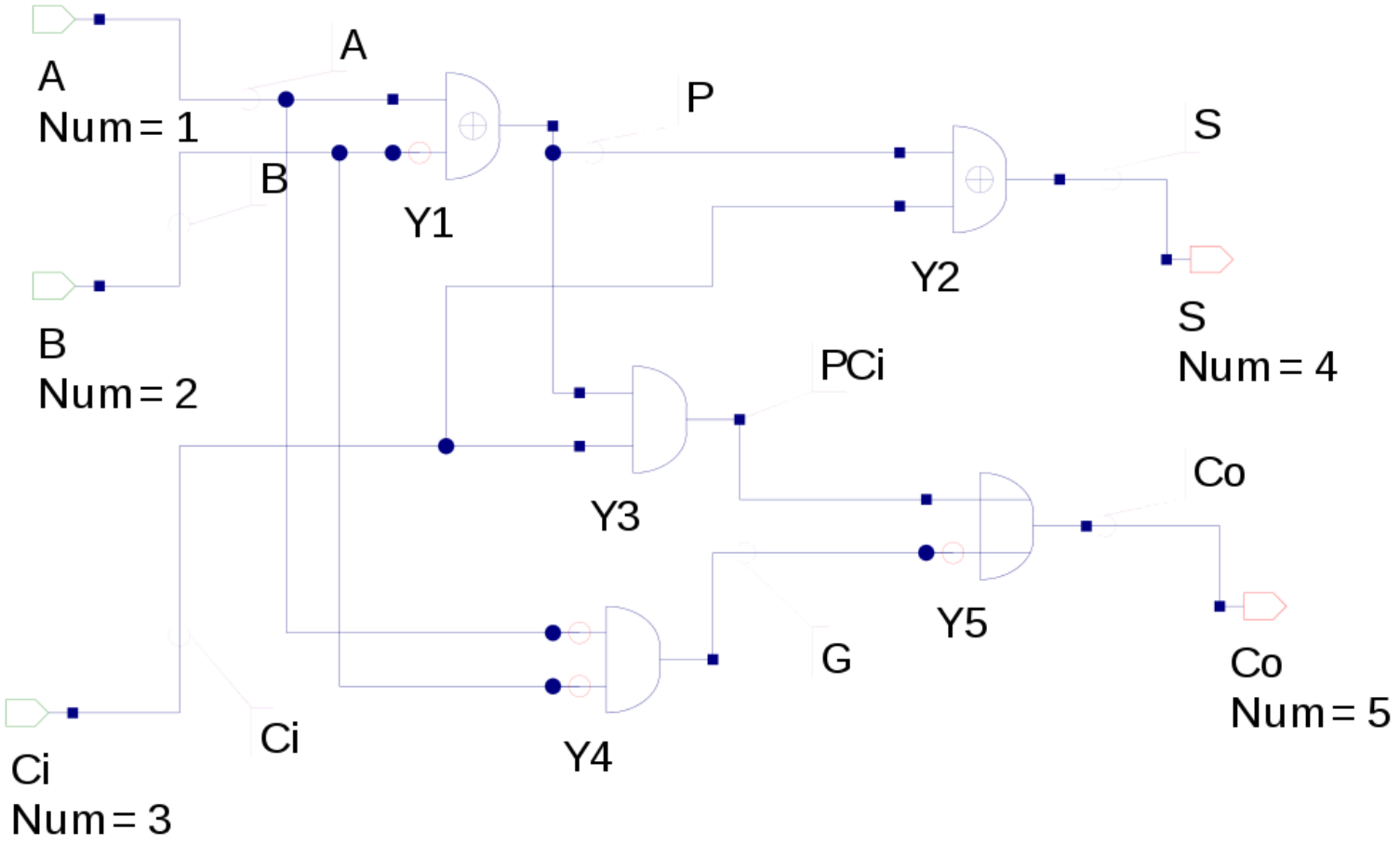
$$\begin{aligned} C_o &= (x + y) C_i + x y \\ &= (\bar{x} y + x \bar{y} + xy) C_i + x y \\ &= (\bar{x} y + x \bar{y}) C_i + xy (C_i + 1) \\ &= (x \oplus y) C_i + xy \end{aligned}$$

$$S = \bar{x}\,\bar{y}\,C_i + \bar{x}\,y\,\bar{C}_i + x\,\bar{y}\,\bar{C}_i + x\,y\,C_i$$

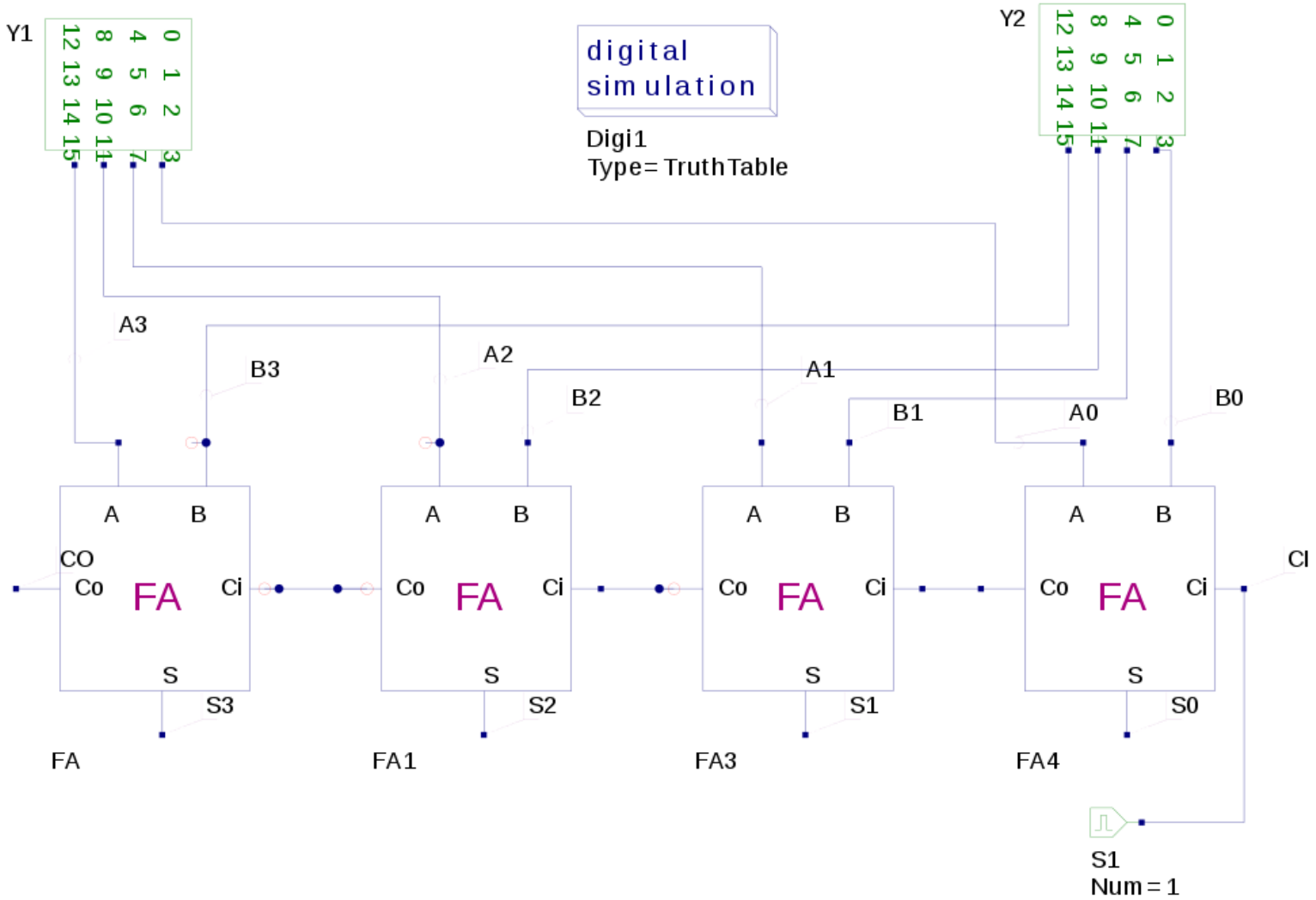
$$\begin{aligned} S &= (\bar{x}\,\bar{y} + xy) C_i + (\bar{x}\,y + x\,\bar{y}) \bar{C}_i \\ &= \overline{(x \oplus y)} C_i + (x \oplus y) \bar{C}_i \\ &= (x \oplus y) \oplus C_i \end{aligned}$$



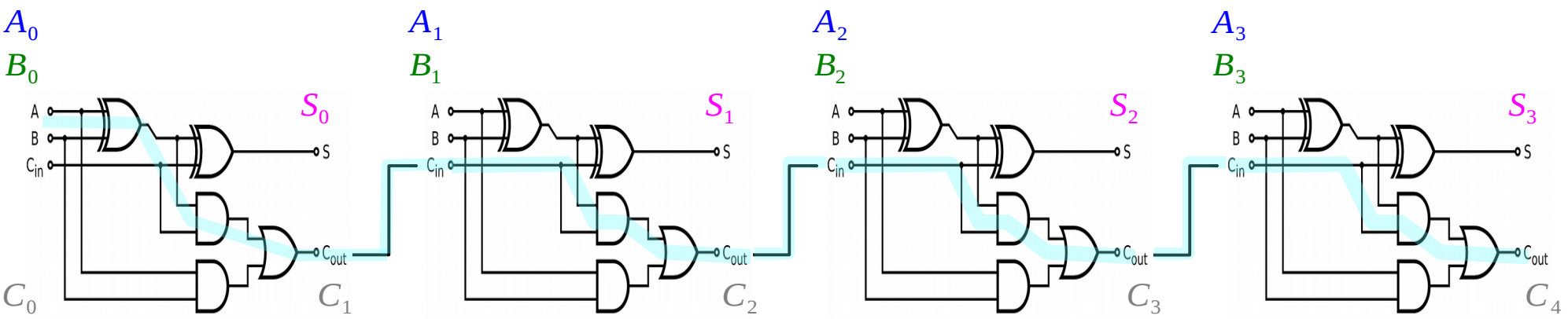
Full Adder in Qucs



4-Bit Adder in Qucs



Critical Path



References

[1] en.wikipedia.org
[2] D.M. Harris, S. L. Harris, “Digital Design and Computer Architecture”
[3] http://www.aoki.ecei.tohoku.ac.jp/arith/mg/algorithm.html