Subsystems: Adder (4G)

Gate Level Design

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

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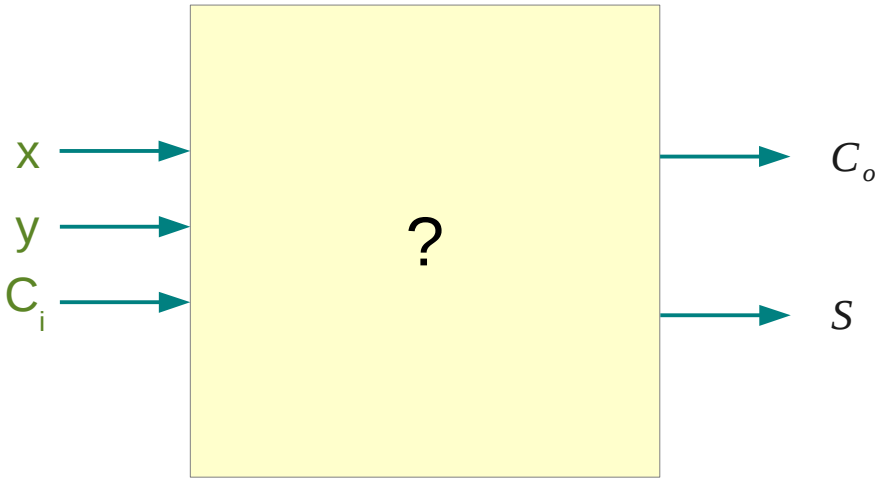
Subsystem Examples

Adders
Multipliers
Memories
Clock
PLL
DLL
I/O

Truth Table

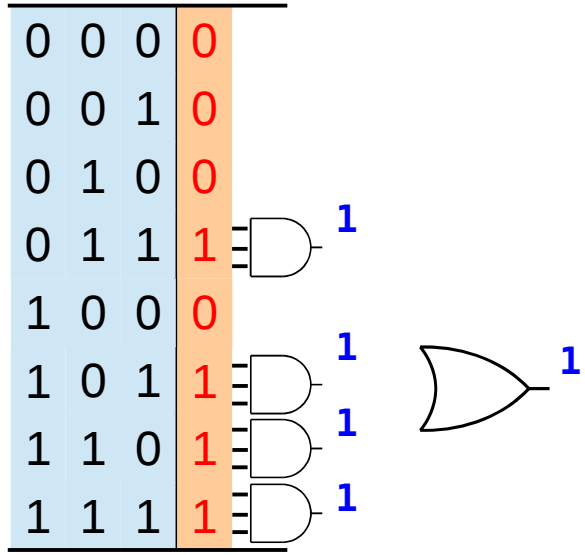
x	y	C_i	C_o	S
0	0	0	0	0
0	0	1	0	1
0	1	0	0	1
0	1	1	1	0
1	0	0	0	1
1	0	1	1	0
1	1	0	1	0
1	1	1	1	1

inputs output

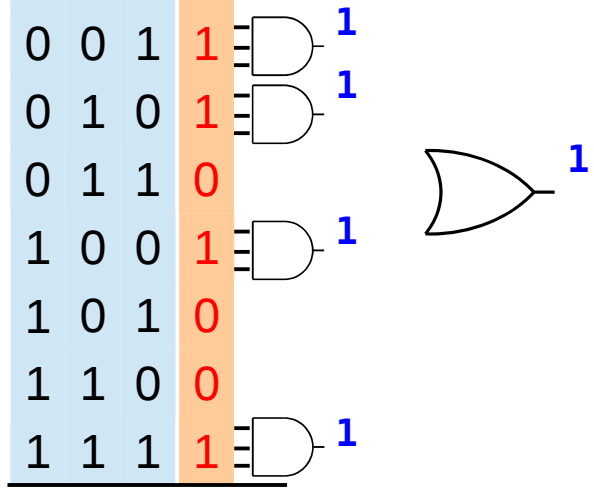


Sum of Product

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

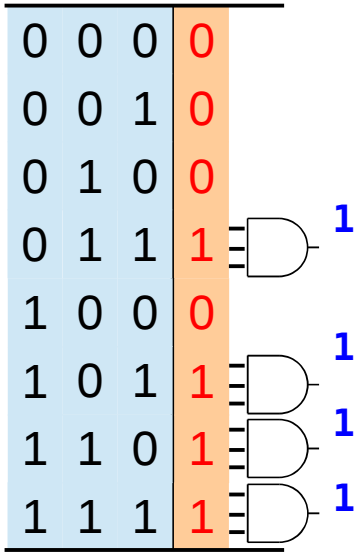


$$C_o = \bar{x}\,y\,C_i + x\,\bar{y}\,C_i + x\,y\,\bar{C}_i + x\,y\,C_i$$

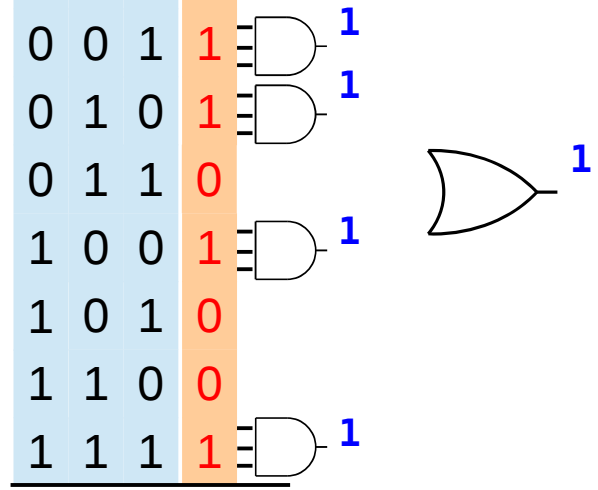
$$S = \bar{x}\,\bar{y}\,C_i + \bar{x}\,y\,\bar{C}_i + x\,\bar{y}\,\bar{C}_i + x\,y\,C_i$$

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

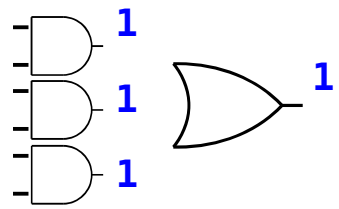


x	y	C_i	S
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	0
1	1	0	0
1	1	1	1



x \ y	0	1
0	0	1
1	1	1

C_i



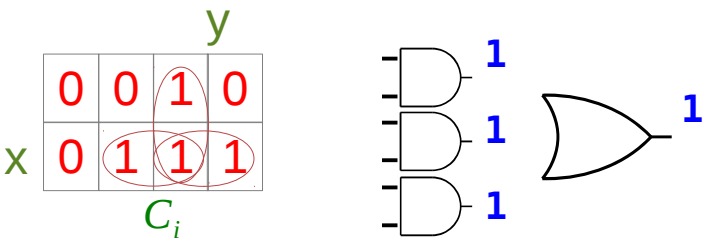
x \ y	0	1
0	0	1
1	1	0

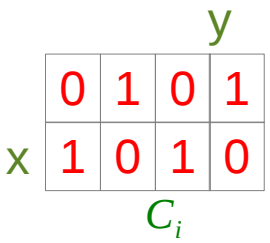
C_i

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

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

Boolean Algebra





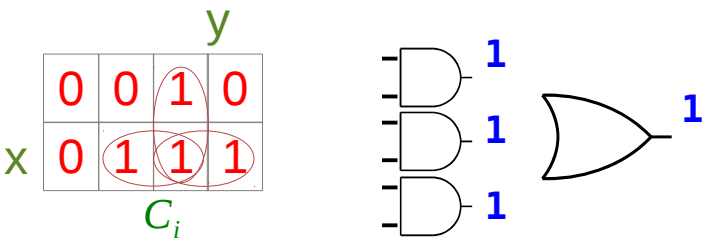
$$C_o = y C_i + x C_i + x y$$

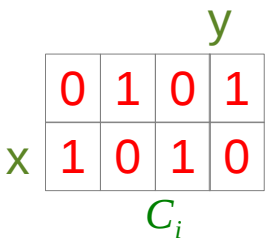
$$\begin{aligned} C_o &= (x + y) C_i + x y \\ &= (\bar{x} y + x \bar{y} + xy) C_i + x y \\ &= (\bar{x} y + x \bar{y}) C_i + xy (C_i + 1) \\ &= (x \oplus y) C_i + xy \end{aligned}$$

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

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

Boolan Algebra





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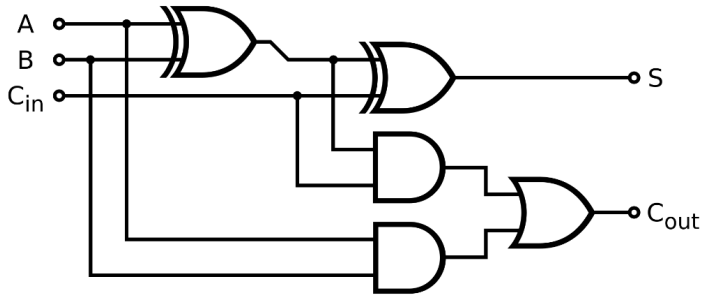
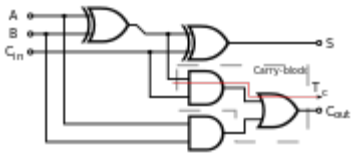
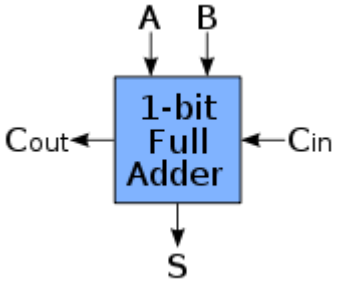
$$S = \bar{x}\,\bar{y}\,C_i + \bar{x}\,y\,\bar{C}_i + x\,\bar{y}\,\bar{C}_i + x\,y\,C_i$$

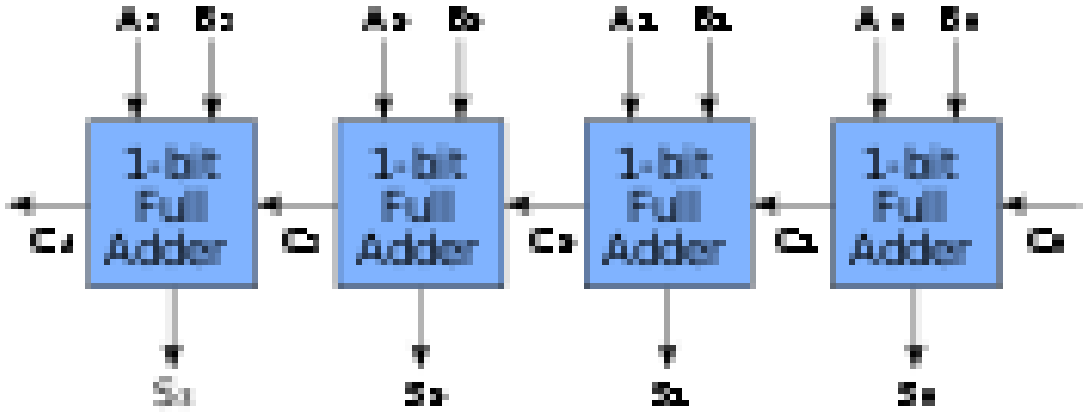
$$\begin{aligned} S &= (\bar{x}\,\bar{y} + xy) C_i + (\bar{x}\,y + x\,\bar{y}) \bar{C}_i \\ &= \overline{(x \oplus y)} C_i + (x \oplus y) \bar{C}_i \\ &= (x \oplus y) \oplus C_i \end{aligned}$$



4-bit Binary Adder







https://en.wikipedia.org/wiki/Adder_(electronics)

References

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[5] J. P. Uyemura, “Introduction to VLSI Circuits and Systems”