

Subsystems: Adder (4G)

Gate Level Design

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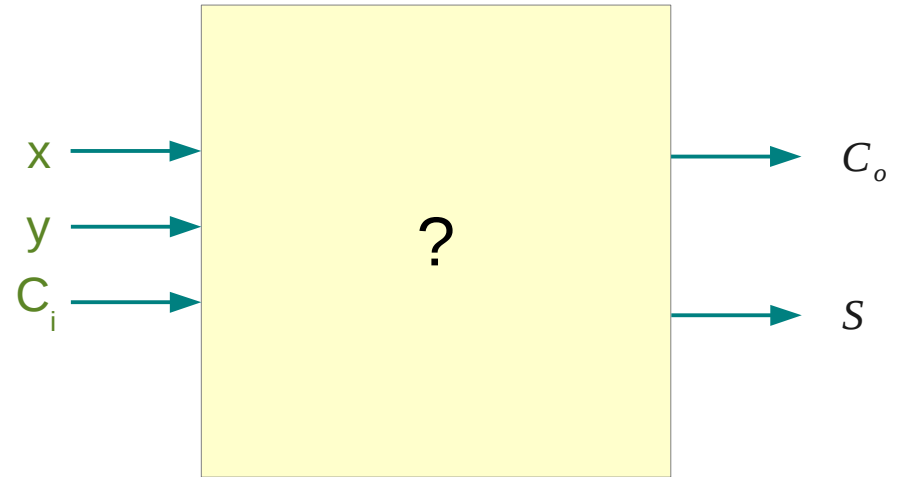
Subsystem Examples

Adders
Multipliers
Memories
Clock
PLL
DLL
I/O

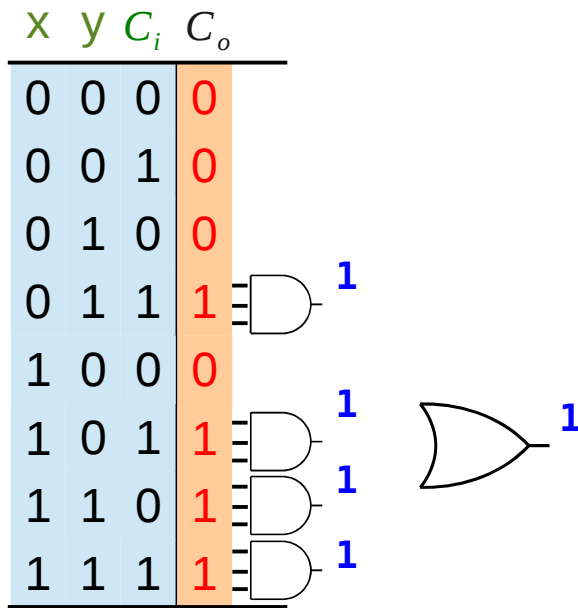
Truth Table

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

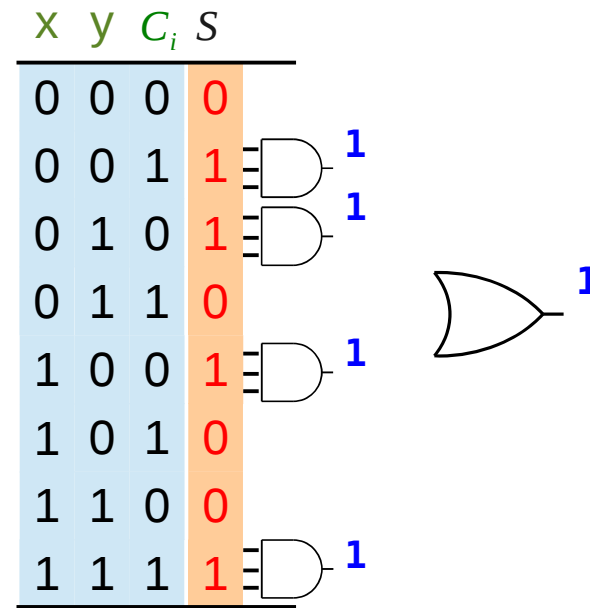
inputs output



Sum of Product

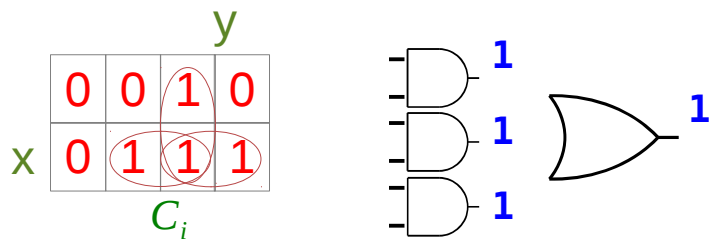
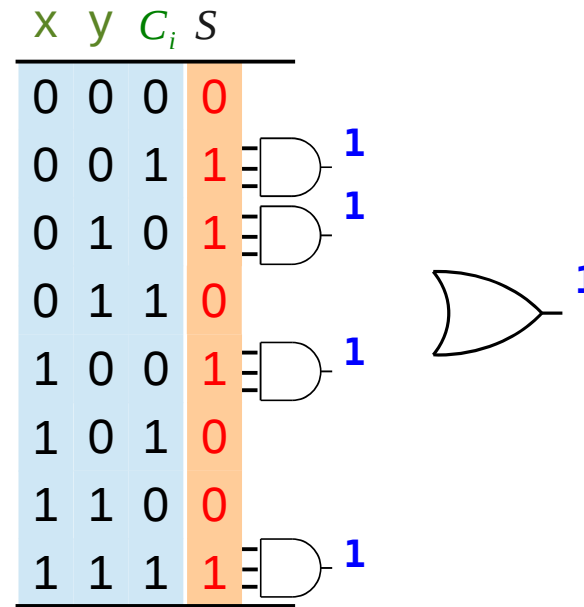
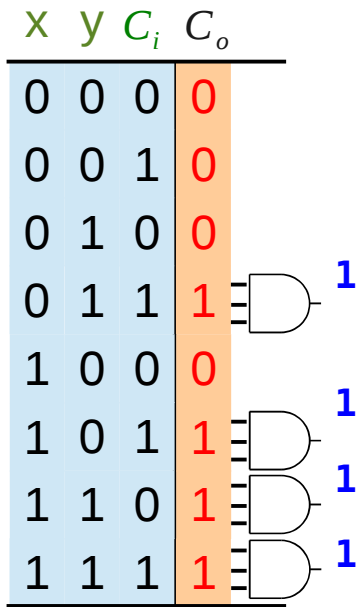


$$C_o = \bar{x}yC_i + x\bar{y}C_i + xy\bar{C}_i + xyC_i$$

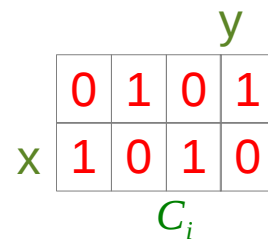


$$S = \bar{x}\bar{y}C_i + \bar{x}y\bar{C}_i + x\bar{y}\bar{C}_i + xyC_i$$

K-Map

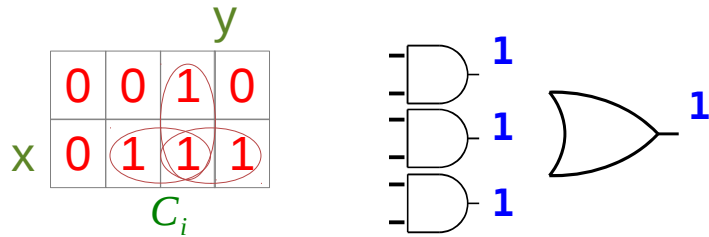


$$C_o = yC_i + xC_i + xy$$



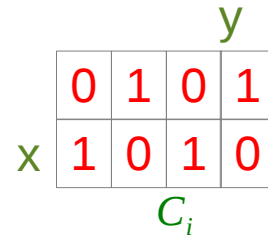
$$S = \bar{x}\bar{y}C_i + \bar{x}y\bar{C}_i + x\bar{y}\bar{C}_i + xyC_i$$

Boolean Algebra



$$C_o = yC_i + xC_i + xy$$

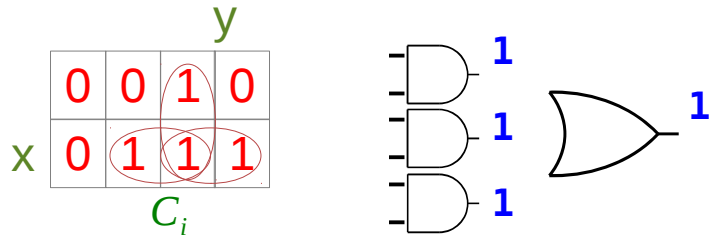
$$\begin{aligned} C_o &= (x + y)C_i + xy \\ &= (\bar{x}y + x\bar{y} + xy)C_i + xy \\ &= (\bar{x}y + x\bar{y})C_i + xy(C_i + 1) \\ &= (x \oplus y)C_i + xy \end{aligned}$$



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

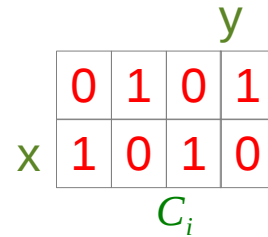
$$\begin{aligned} S &= (\bar{x}\bar{y} + xy)C_i + (\bar{x}y + x\bar{y})\bar{C}_i \\ &= \overline{(x \oplus y)}C_i + (x \oplus y)\bar{C}_i \\ &= (x \oplus y) \oplus C_i \end{aligned}$$

Boolean Algebra



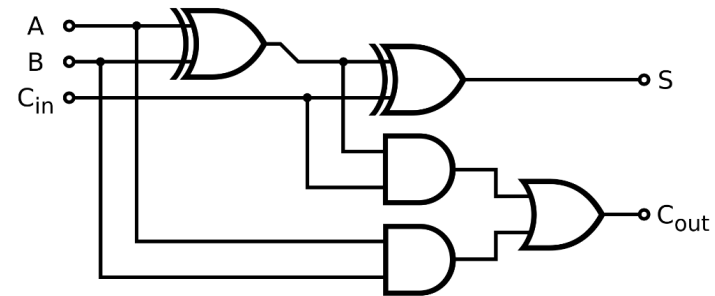
$$C_o = yC_i + xC_i + xy$$

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

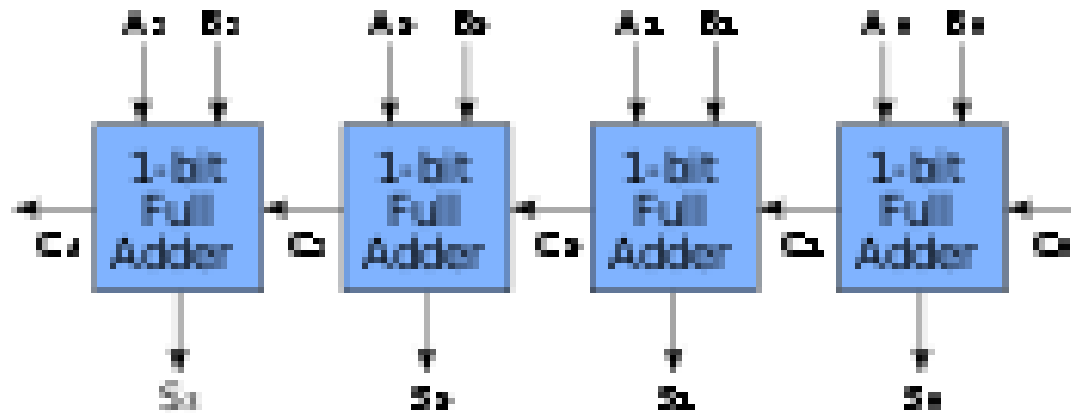
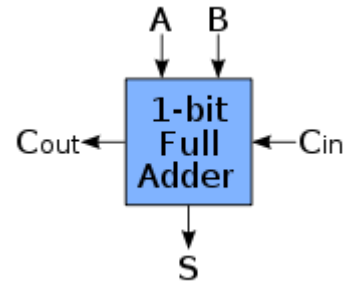
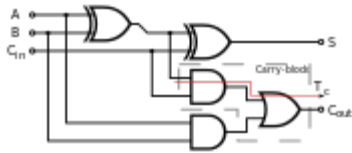


$$S = \bar{x}\bar{y}C_i + \bar{x}y\bar{C}_i + x\bar{y}\bar{C}_i + xyC_i$$

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



4-bit Binary Adder



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

References

- [1] <http://en.wikipedia.org/>
- [2] <http://www.allaboutcircuits.com/>
- [3] W. Wolf, "Modern VLSI Design : Systems on Silicon"
- [4] N. Weste, D. Harris, "CMOS VLSI Design: A Circuits and Systems Perspective"
- [5] J. P. Uyemura, "Introduction to VLSI Circuits and Systems"