Combinational Gates

Gate Level Design

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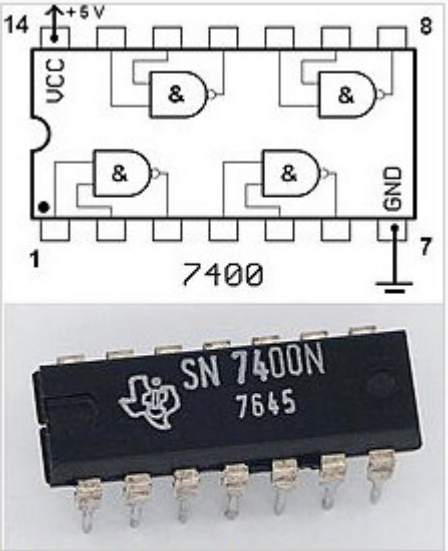
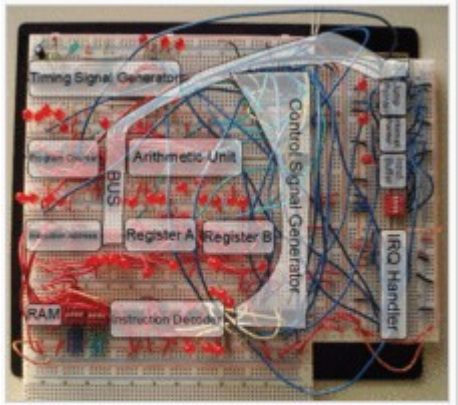
TTL Gates : Building Blocks in 70's & 80's



The 7400 chip, containing four NANDs. The second line of numbers (7645) is a date code; this chip was manufactured in the 45th week of 1976.[1] The N suffix on the part number is a vendor-specific code indicating PDIP packaging.

Surface-mounted 74HC595 shift registers on a PCB. This IC is actually a high-speed cmos circuit. If the product code had been 74HCT595, it would have been compatible with TTL signalling levels.



A 4-bit, 2 register, six-instruction computer made entirely of 74-series chips

https://en.wikipedia.org/wiki/7400_series

TTL Logic Gates

- Buffers/Inverters/Drivers
- Digital Multiplexers
- Bus Switches
- Encoders
- Comparators
- Decoders/Demultiplexers
- Digital Comparators
- Gates
- Parity Generators/Checkers

Combinational Logic Gates

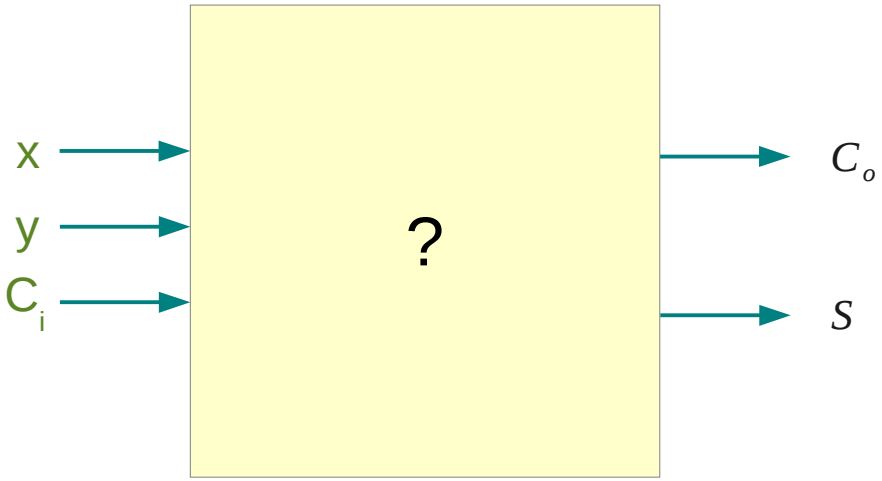
- Flip-Flops
- FIFO Registers
- Counters/Frequency Dividers
- Latches/Registered Drivers
- Shift Registers

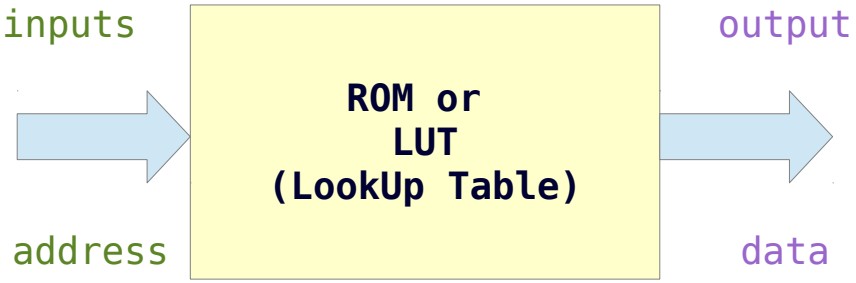
Seqauential Logic Gates

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



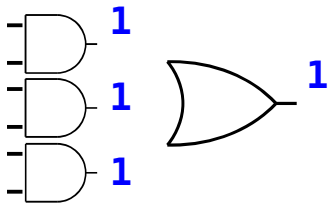


SOP and K-Map Minimization

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

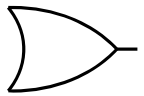
x \ y	0	1
0	0	1
0	1	1
1	0	1

C_i



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

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

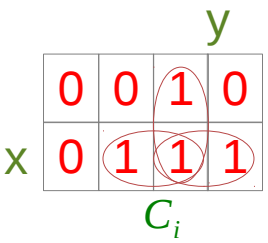


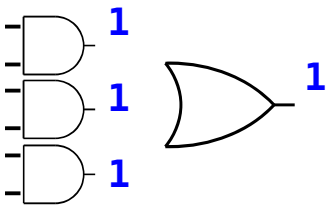
x \ y	0	1
0	0	1
1	1	0

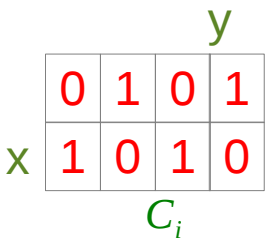
C_i

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

Boolean Algebra





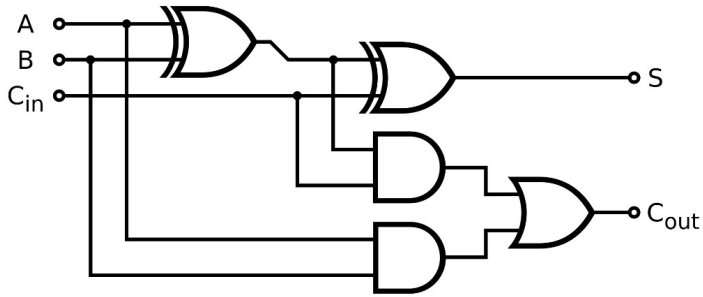


$$C_o = y C_i + x C_i + x y$$

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

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

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



References

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[10] https://en.wikiversity.org/wiki/The_necessities_in_Computer_Organization