The Ubiquitous Chip

or Solid State Electronics

- **Electrical - Electricity is the power source**
- **Electronic - Electricity carries information**

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- **Voltage - Electrical Pressure**
- **Current - Electrical charge flow rate**

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- **Signal - An information stream**

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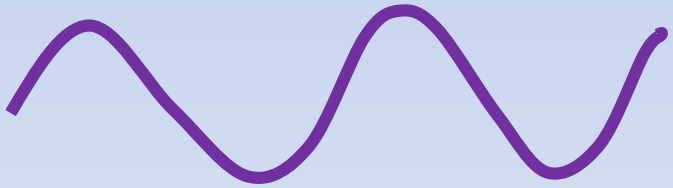
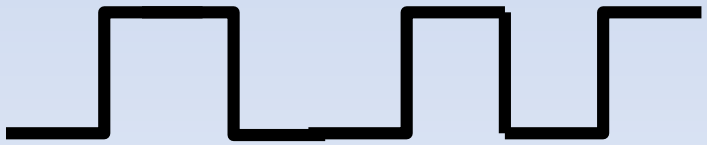
- **Voltage - Electrical Pressure**
- **Current - Electrical charge flow rate**

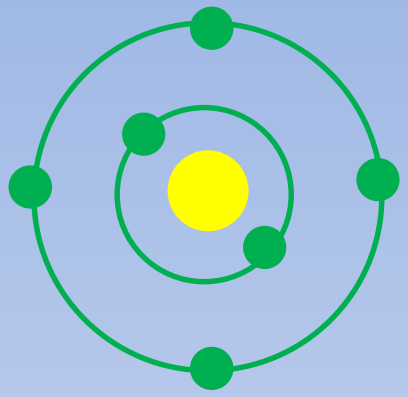
- **Signal - An information stream**

- **Analogue**

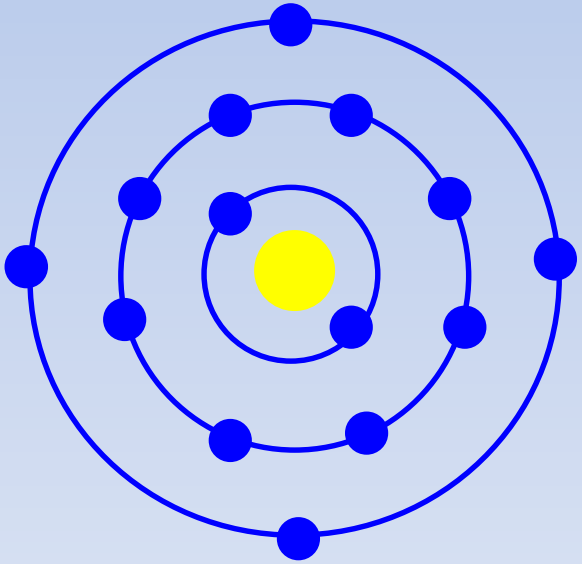


- **Digital**

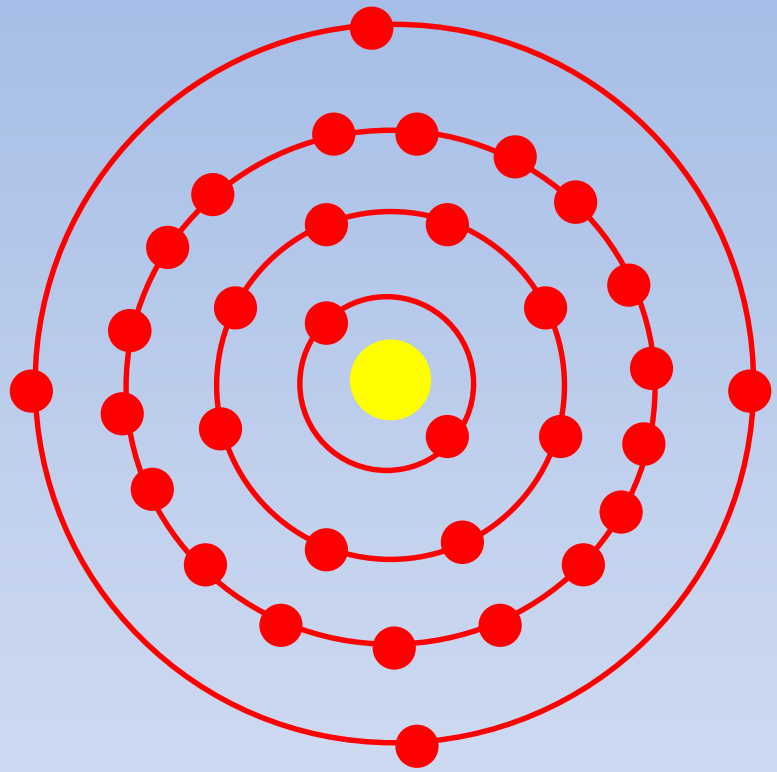




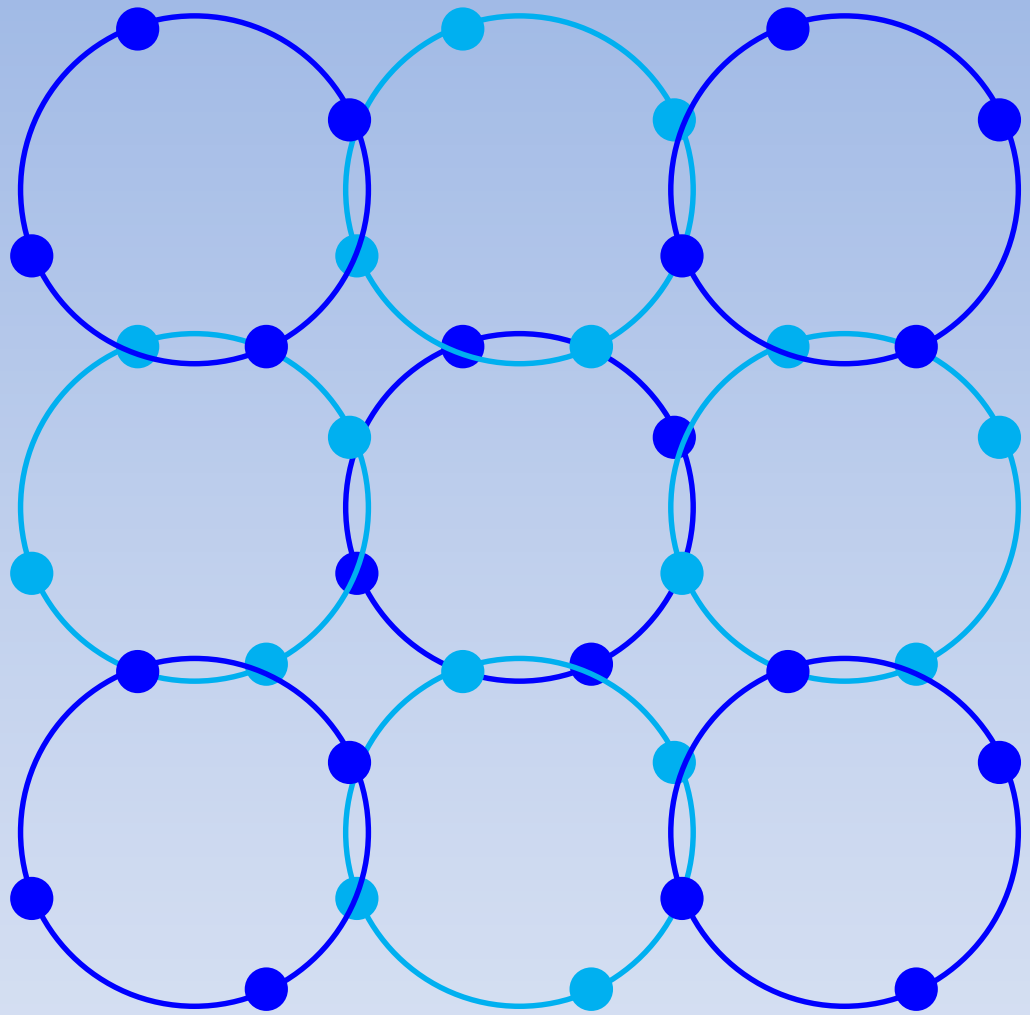
Carbon



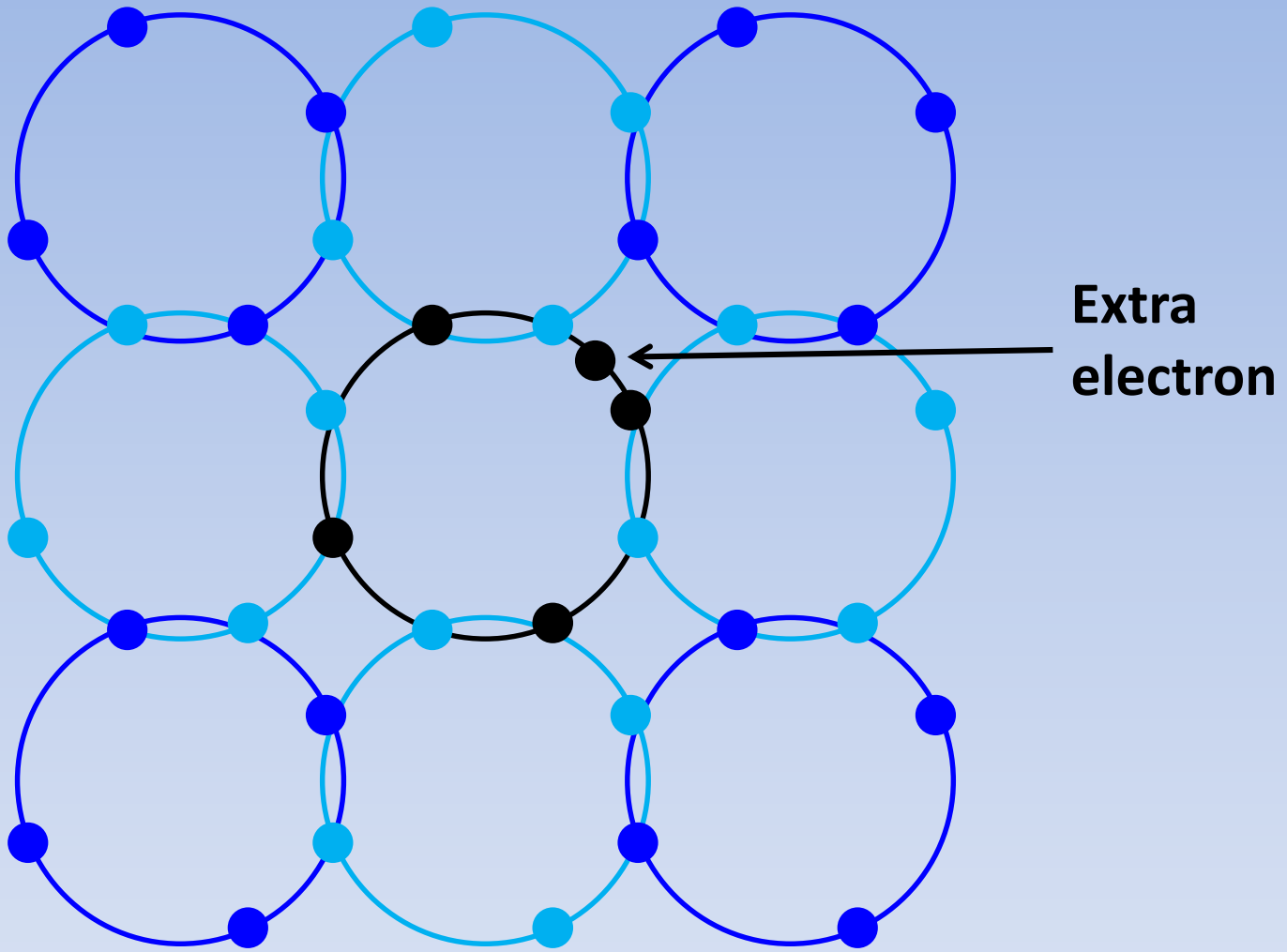
Silicon



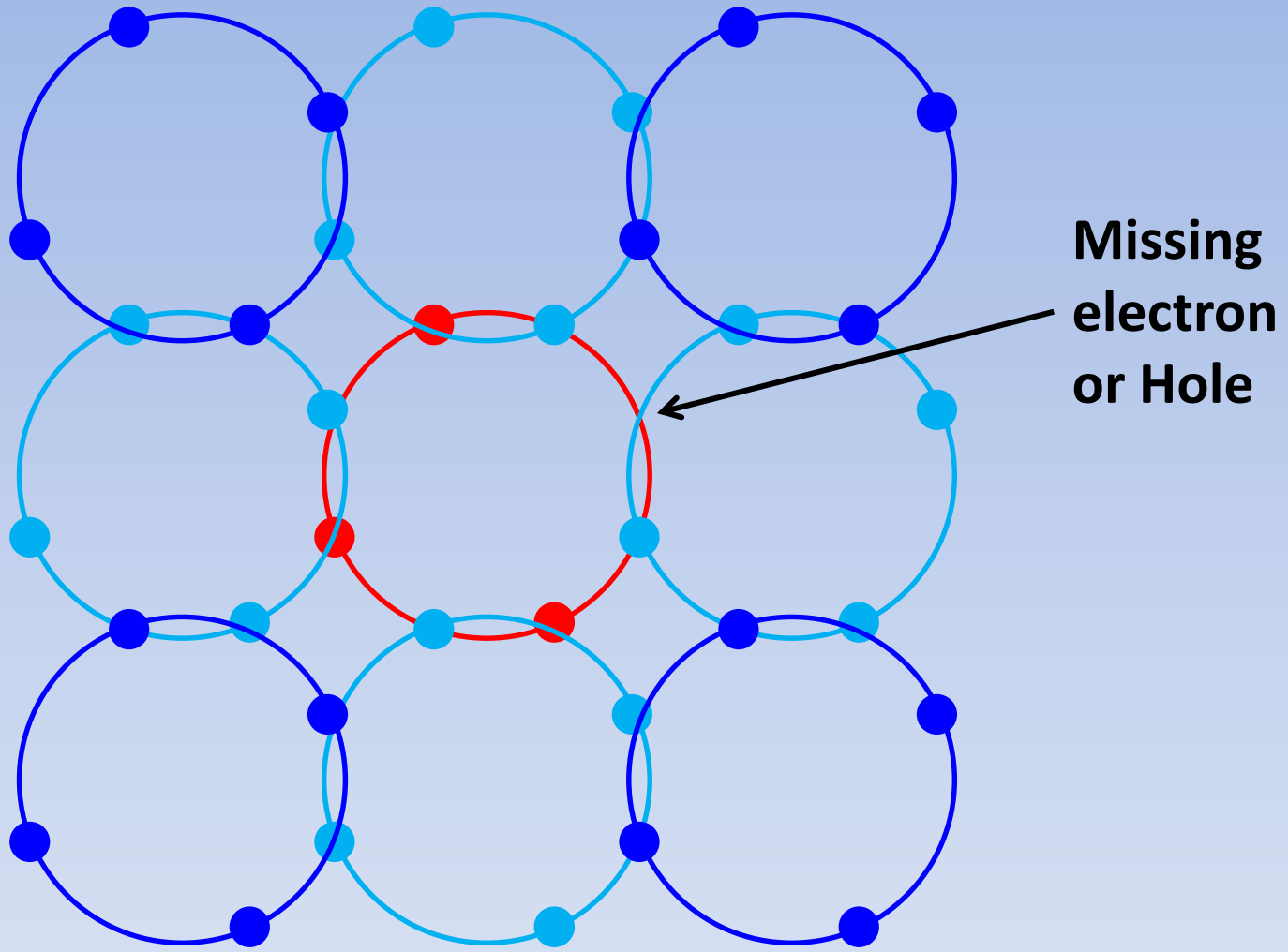
Germanium



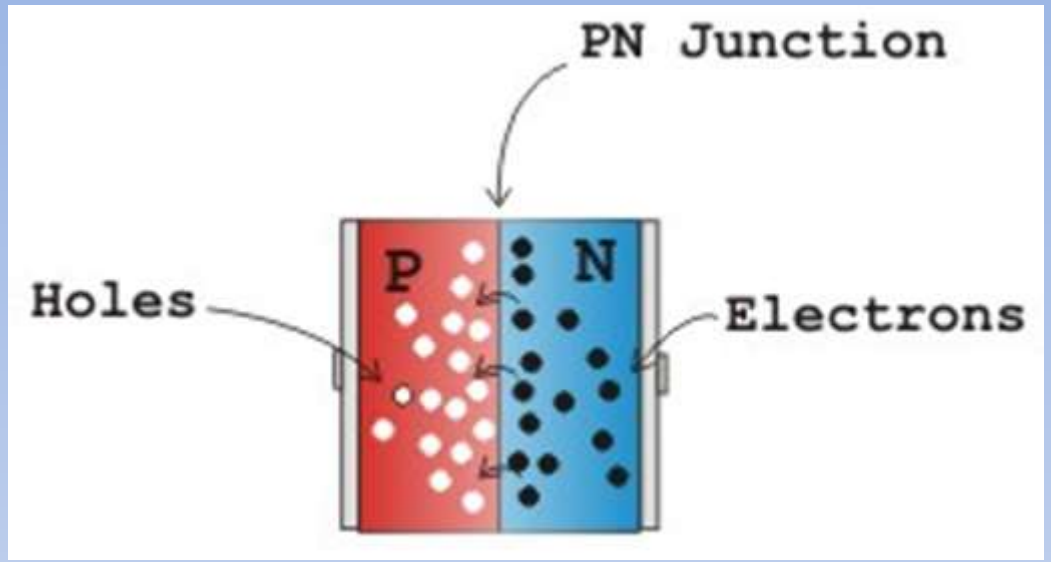
2-D Version of a Silicon Crystal

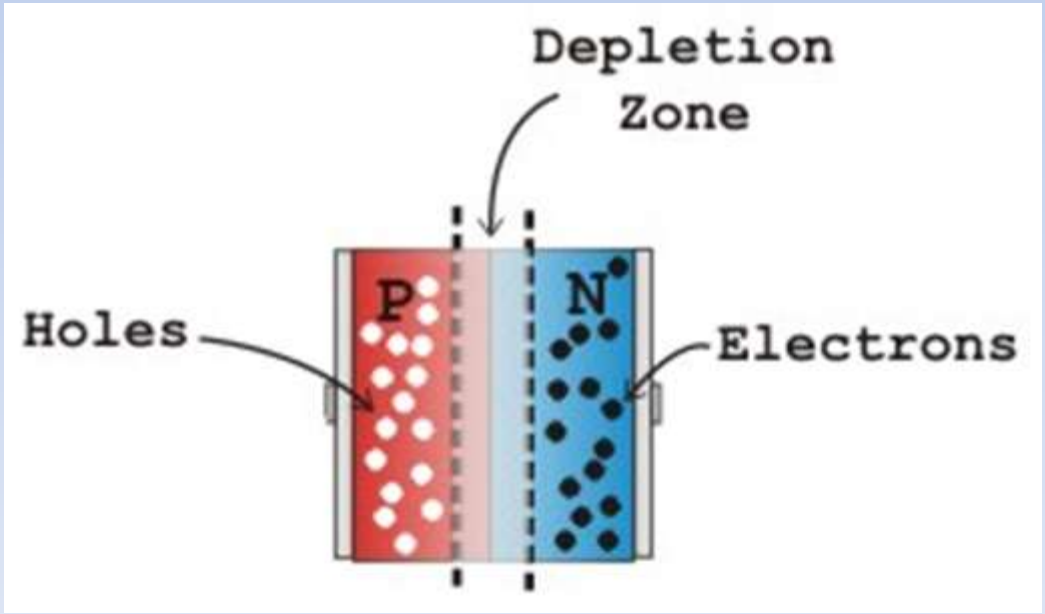


n-type silicon

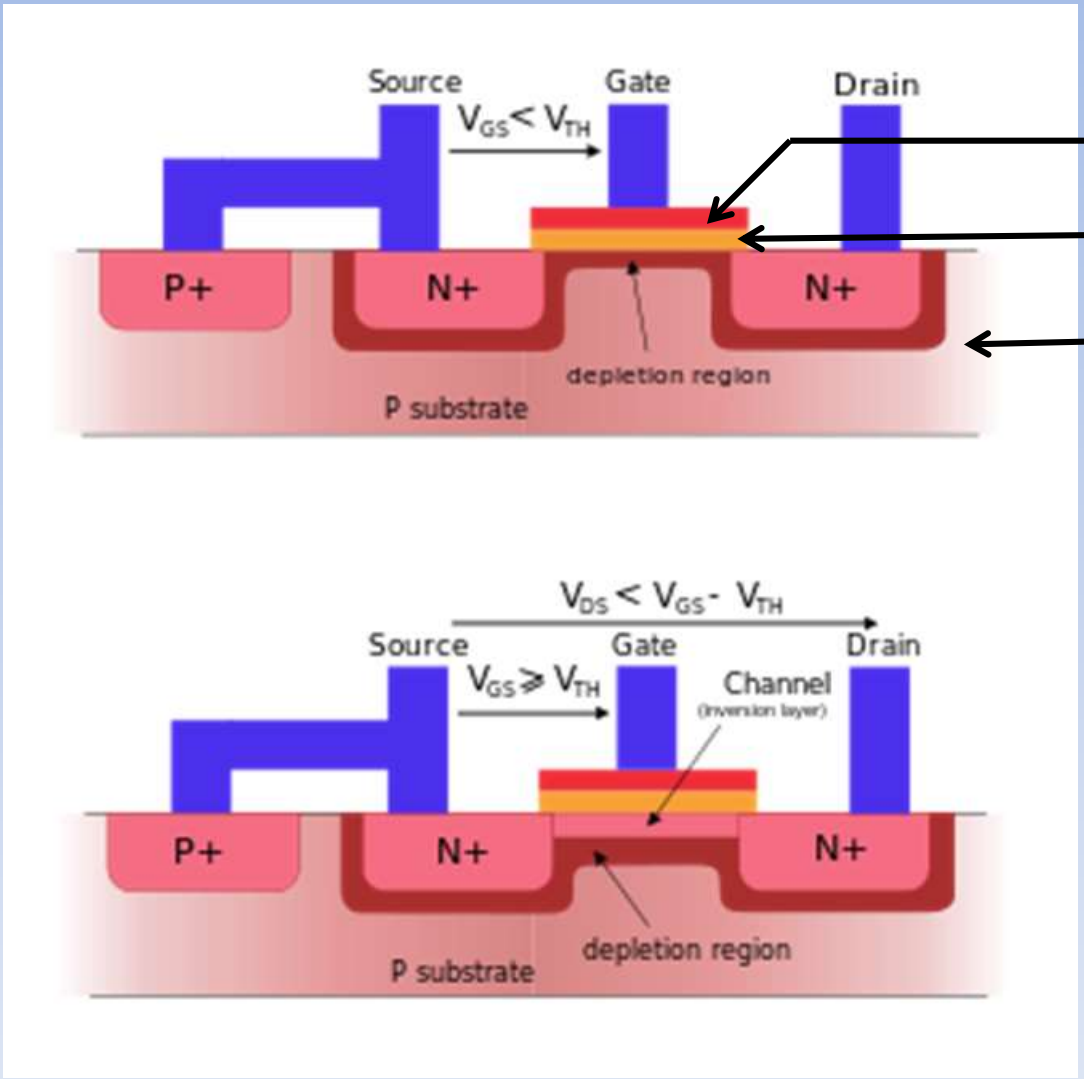


p-type silicon


PN Junction
P
N
Holes
Electrons


Depletion
Zone
P
N
Holes
Electrons

The MOSFET - Metal Oxide Semiconductor Field Effect Transistor

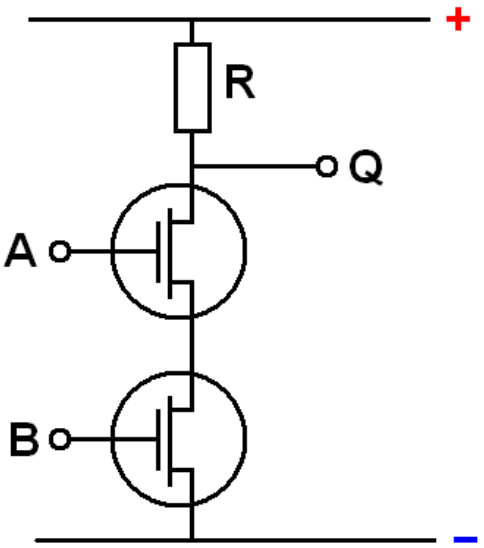


Metal

Oxide

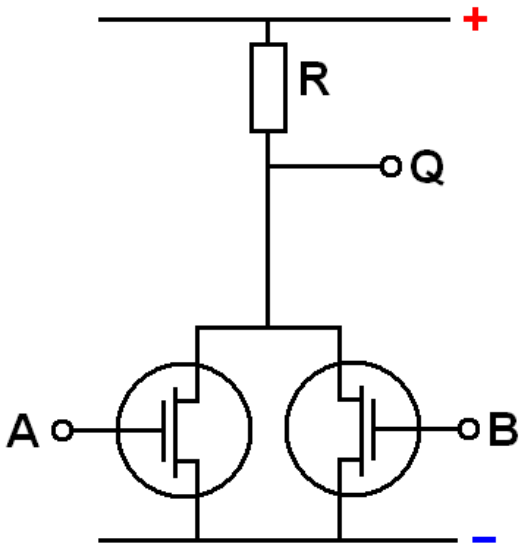
Semiconductor

Logic Circuits (or Gates)



Q = A NAND B

0 NAND 0 = 1
0 NAND 1 = 1
1 NAND 0 = 1
1 NAND 1 = 0



Q = A NOR B

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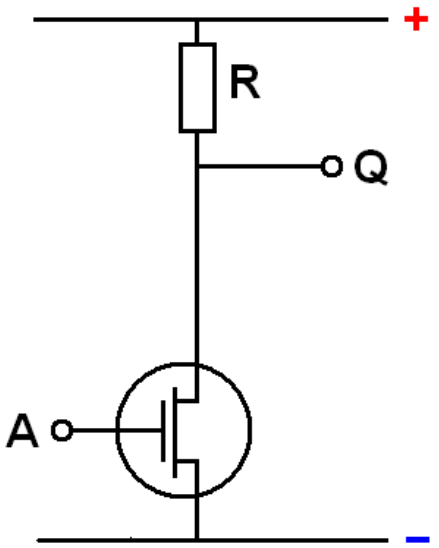
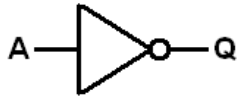
0 NOR 1 = 1
1 NOR 0 = 1
1 NOR 1 = 1

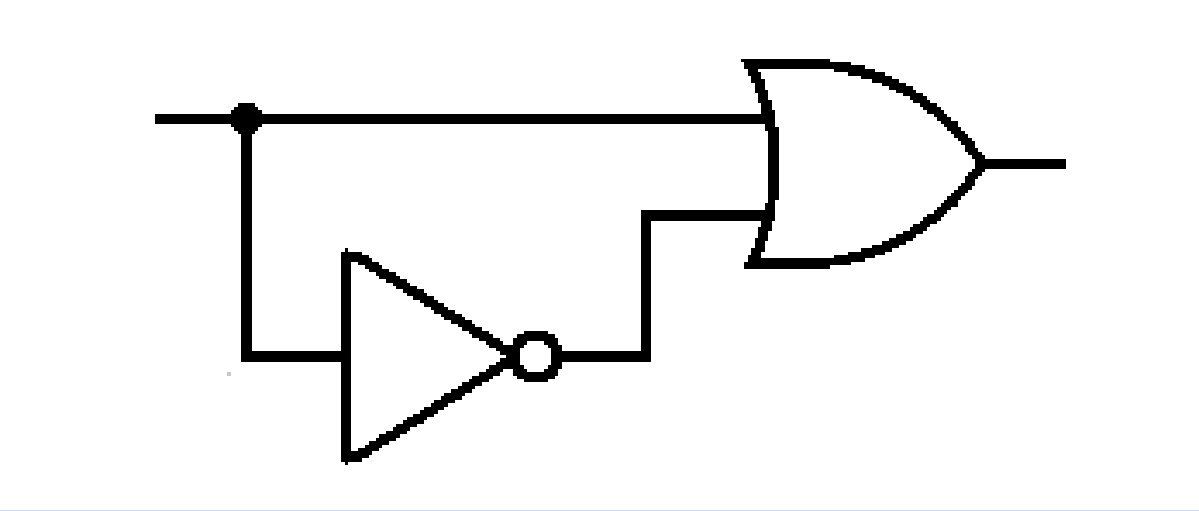


Q = NOT A

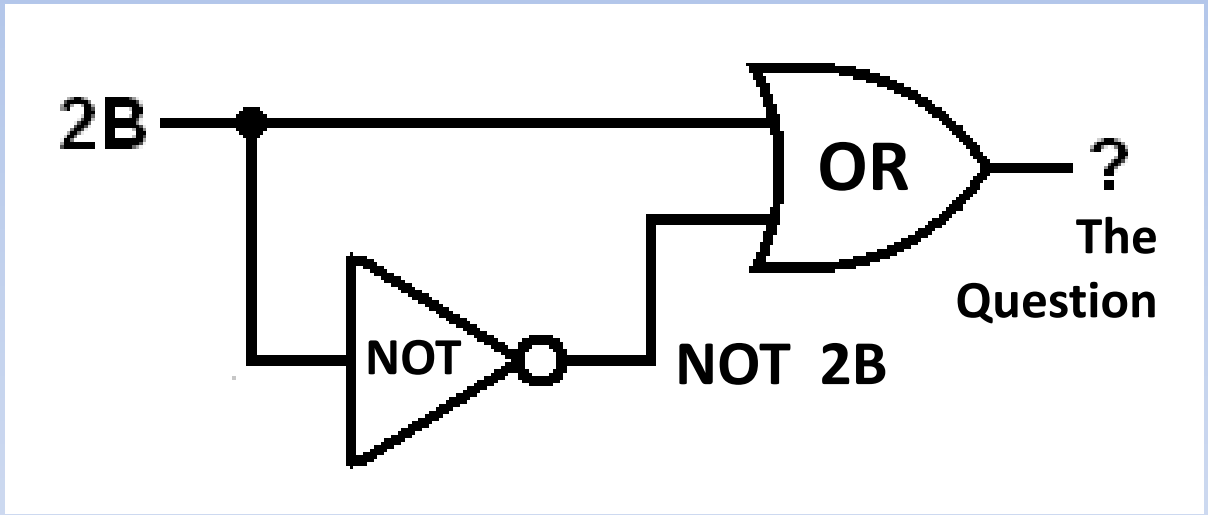


NOT 0 = 1
NOT 1 = 0

The Shakespeare Circuit



The Shakespeare Circuit



The Binary System

1 x 64
1 x 32
0 x 16
0 x 8
0 x 4
1 x 2
1 x 1 +

---

99 decimal = 1100011 binary

The Binary System

1	x	64	
1	x	32	
0	x	16	
0	x	8	
0	x	4	
1	x	2	
1	x	1	+

99 decimal = 1100011 binary

5	101
6 +	110 +
11	1011

The Binary System

5	101
6 +	110 +
11	1011

Exclusive OR

0 XOR 0 = 0
0 XOR 1 = 1
1 XOR 0 = 1
1 XOR 1 = 0

The Binary System

0 OR 0 = 0
0 OR 1 = 1
1 OR 0 = 1
1 OR 1 = 1

OR

5	101
6 +	110 +
11	1011

0 XOR 0 = 0
0 XOR 1 = 1
1 XOR 0 = 1
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Exclusive OR

The Binary System

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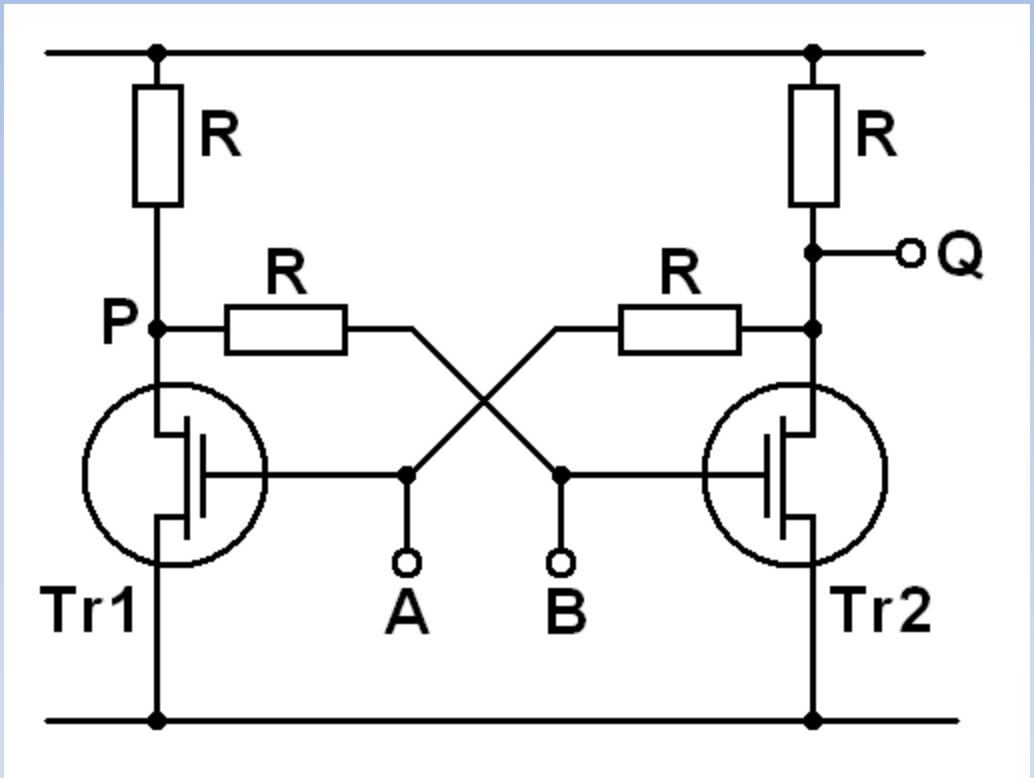
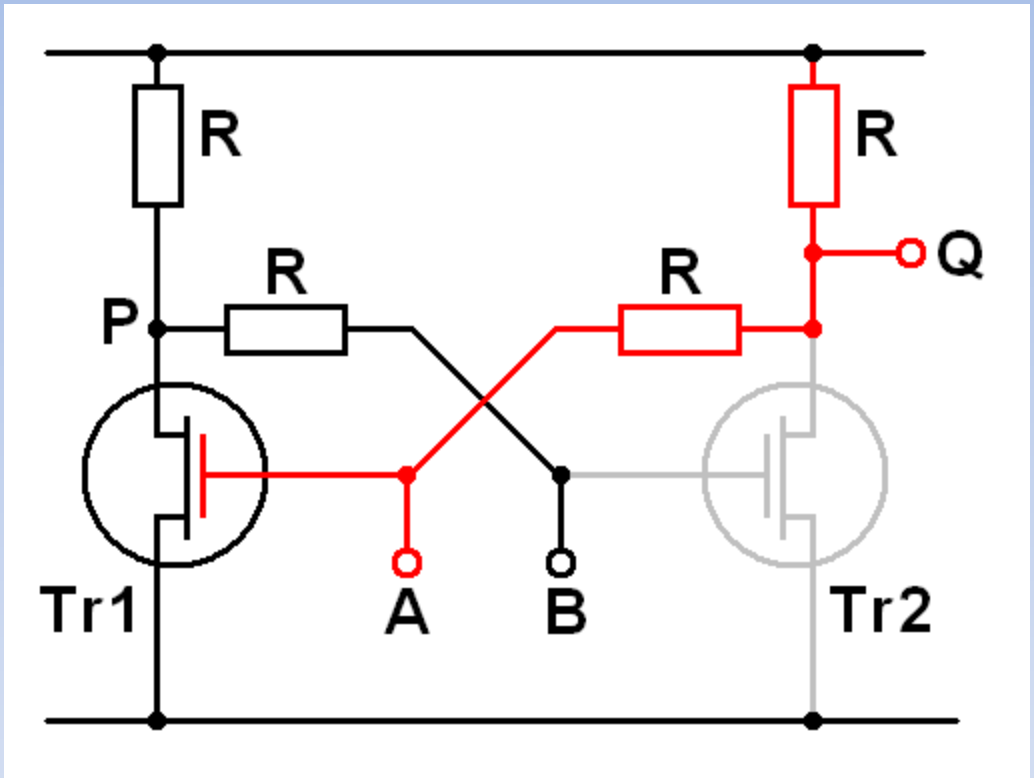
Exclusive OR

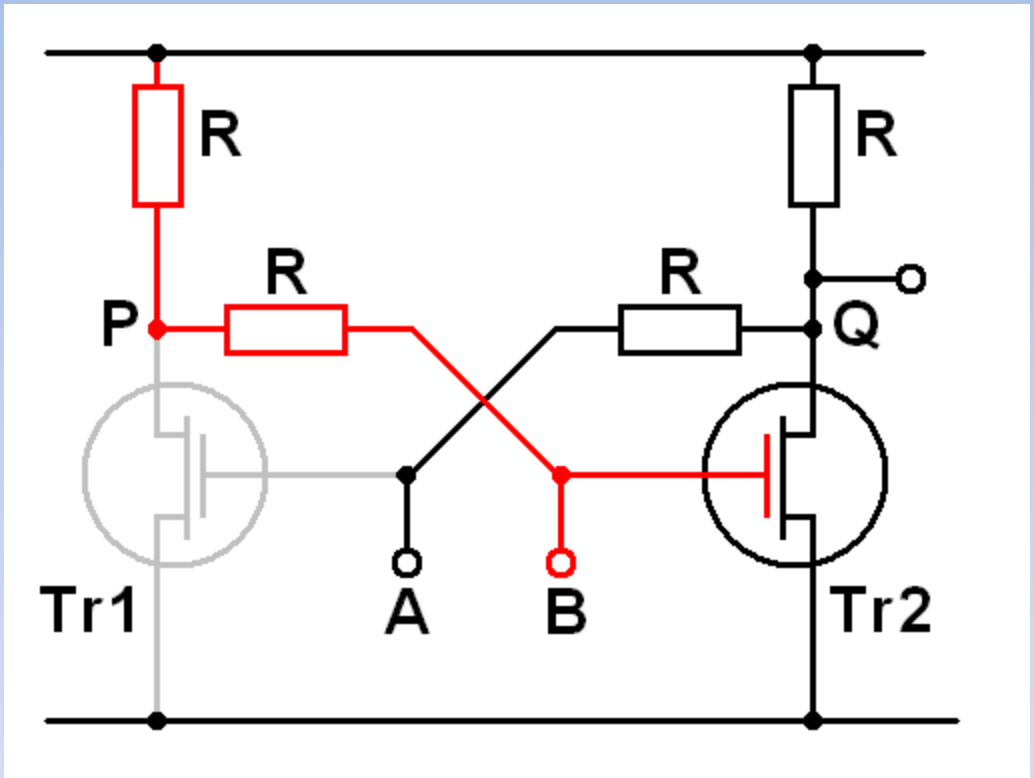
The Flip-Flop - A Memory Circuit



The Flip-Flop - A Memory Circuit



The Flip-Flop - A Memory Circuit

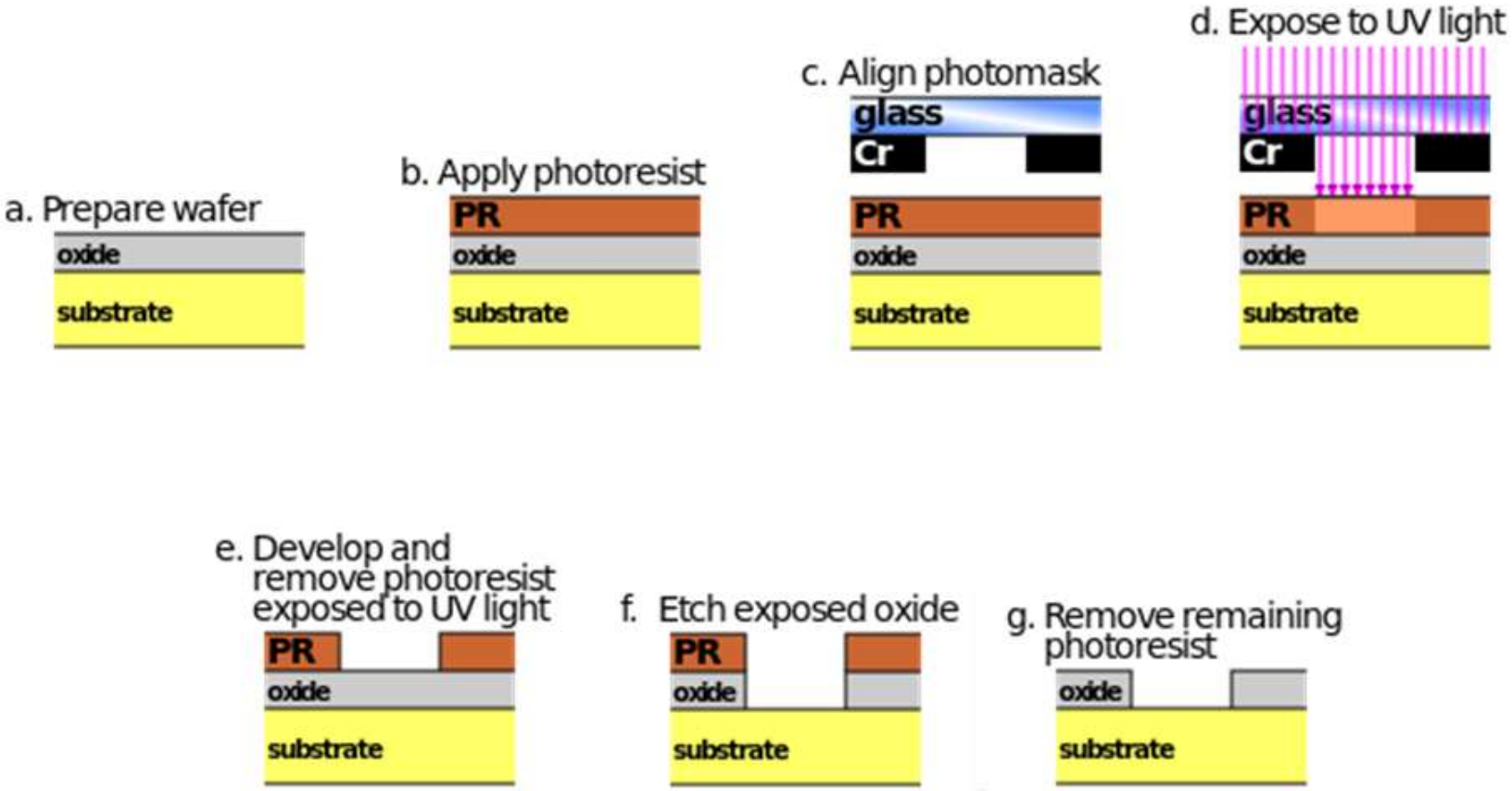


Silicon Manufacture

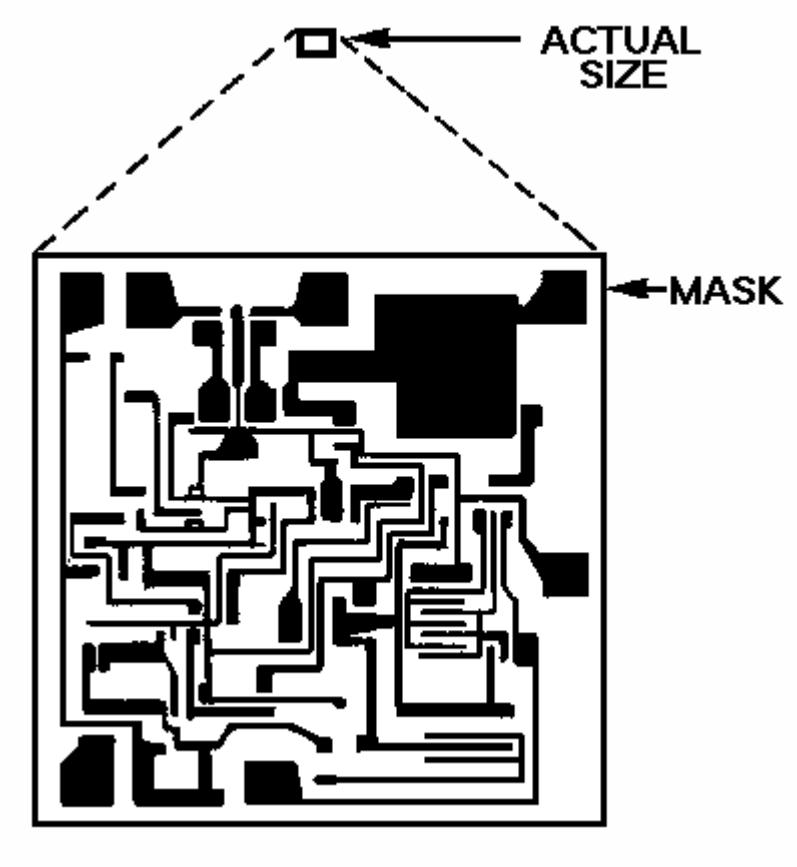
Silicon Manufacture

Silicon Manufacture

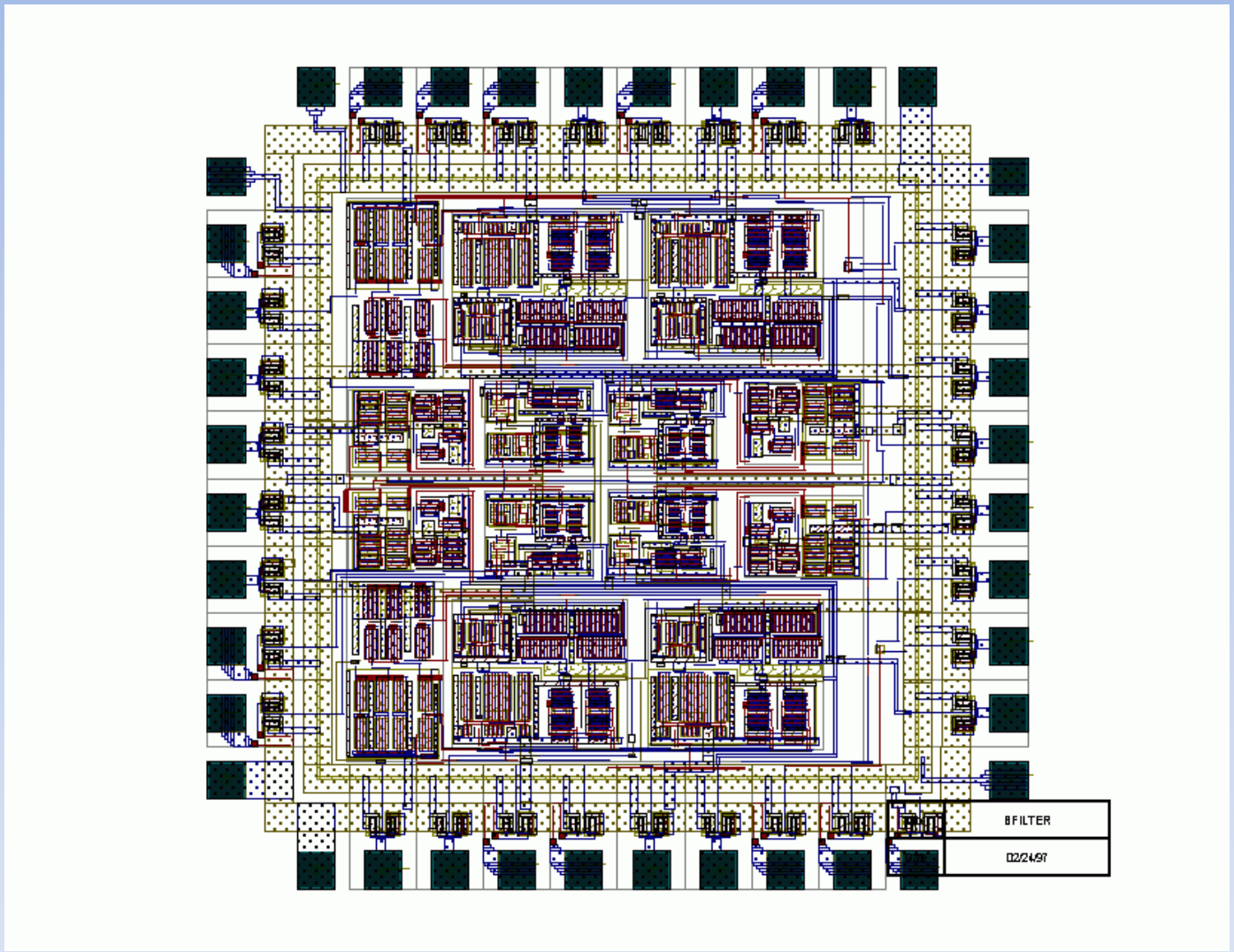
Integrated Circuit Manufacture



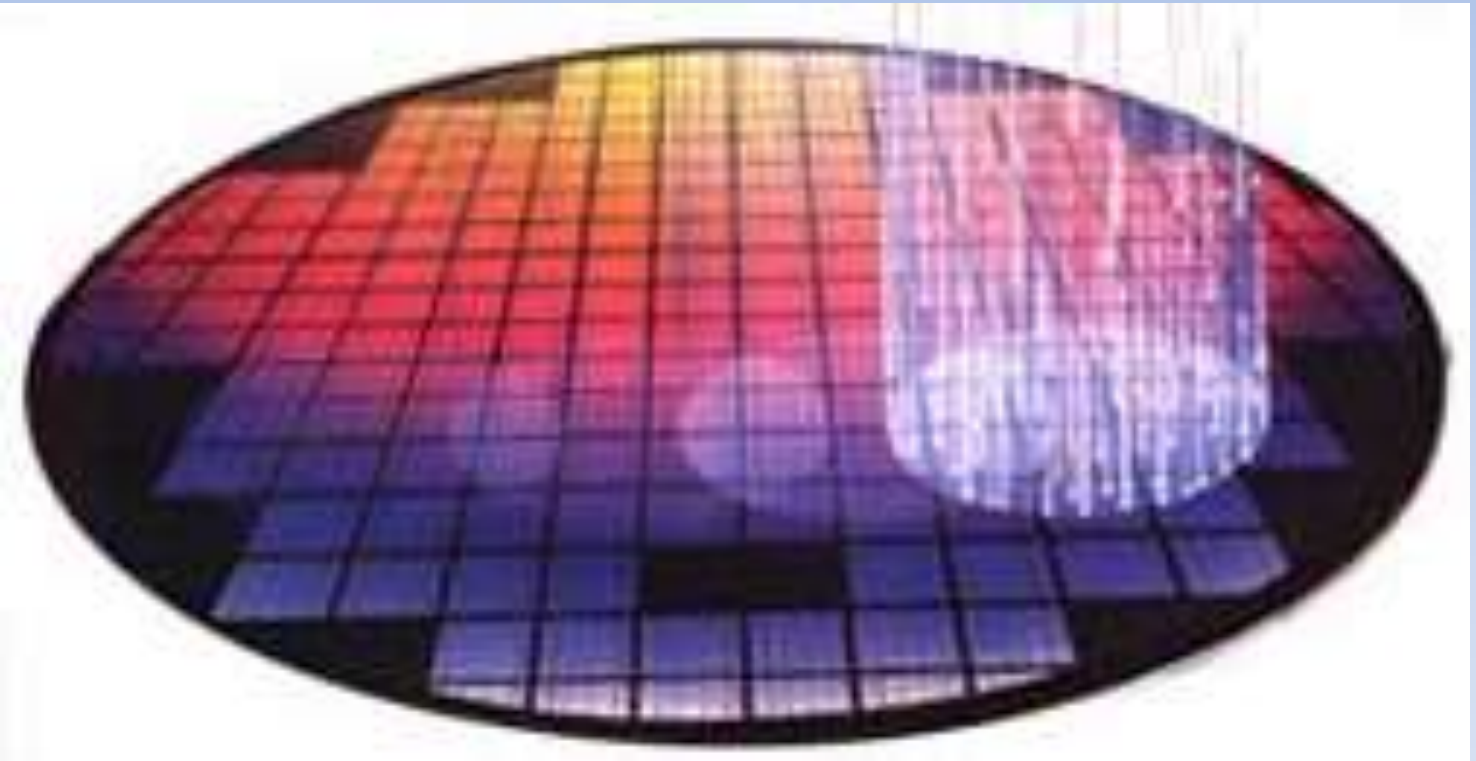
Integrated Circuit Manufacture - Photographic Masks



Integrated Circuit Manufacture - Photographic Masks



Integrated Circuit Manufacture - Ion Implantation



Chip Components – Smallest Dimensions

1975	1 micron	0.001 mm
2013	20 nanometers	0.00002 mm

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1975	1 micron	0.001 mm
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Silicon Wafer Sizes

1975	2.5 inches diameter
2013	12 inches diameter

RISC

CISC

RISC	CISC
Small	Large

RISC	CISC
Small	Large
Cheap	Expensive

RISC	CISC
Small	Large
Cheap	Expensive
Fast	Slow

RISC	CISC
Small	Large
Cheap	Expensive
Fast	Slow
Low Power	High Power

RISC	CISC
Small	Large
Cheap	Expensive
Fast	Slow
Low Power	High Power
More Reliable	Less Reliable

RISC	CISC
Small	Large
Cheap	Expensive
Fast	Slow
Low Power	High Power
More Reliable	Less Reliable
Runs Cool	Runs Hot

RISC	CISC
Acorn ARM	Intel 80486
4 MHz	33 MHz
1.61 seconds	1.59 seconds