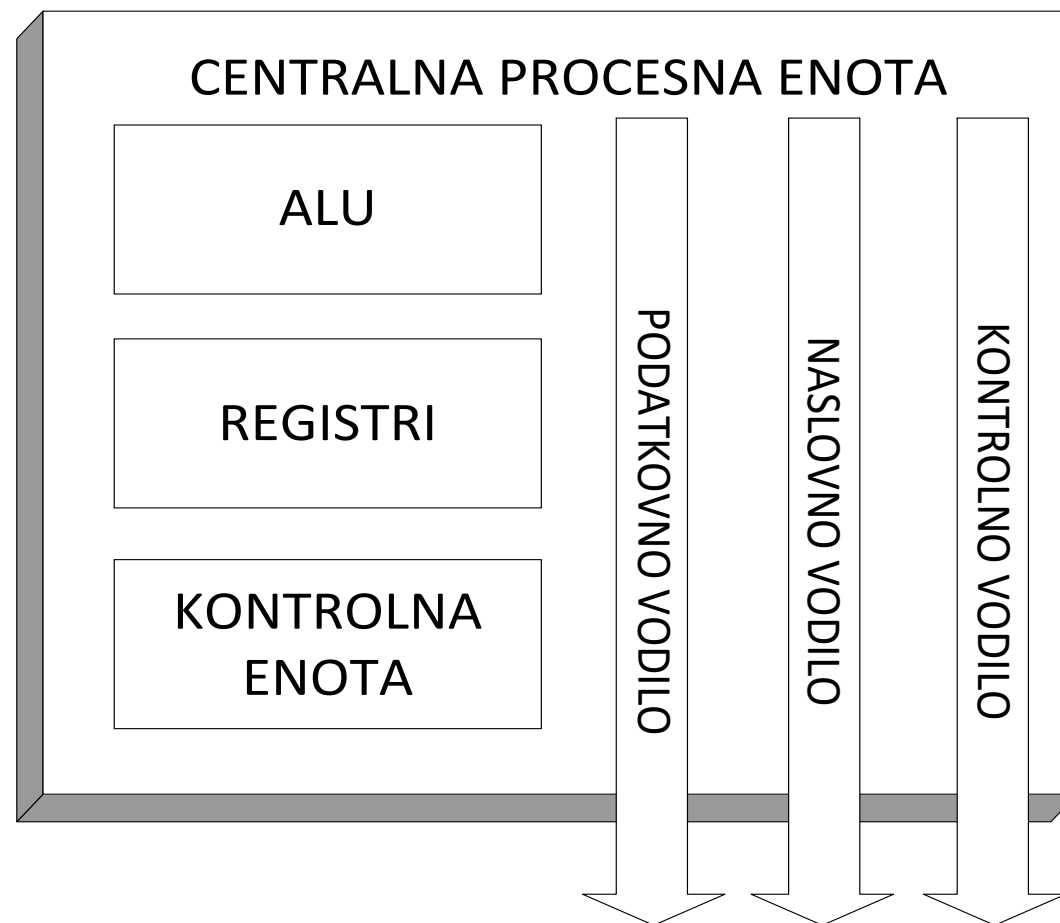


Osnove mikroprocesorske elektronike

Marko Jankovec

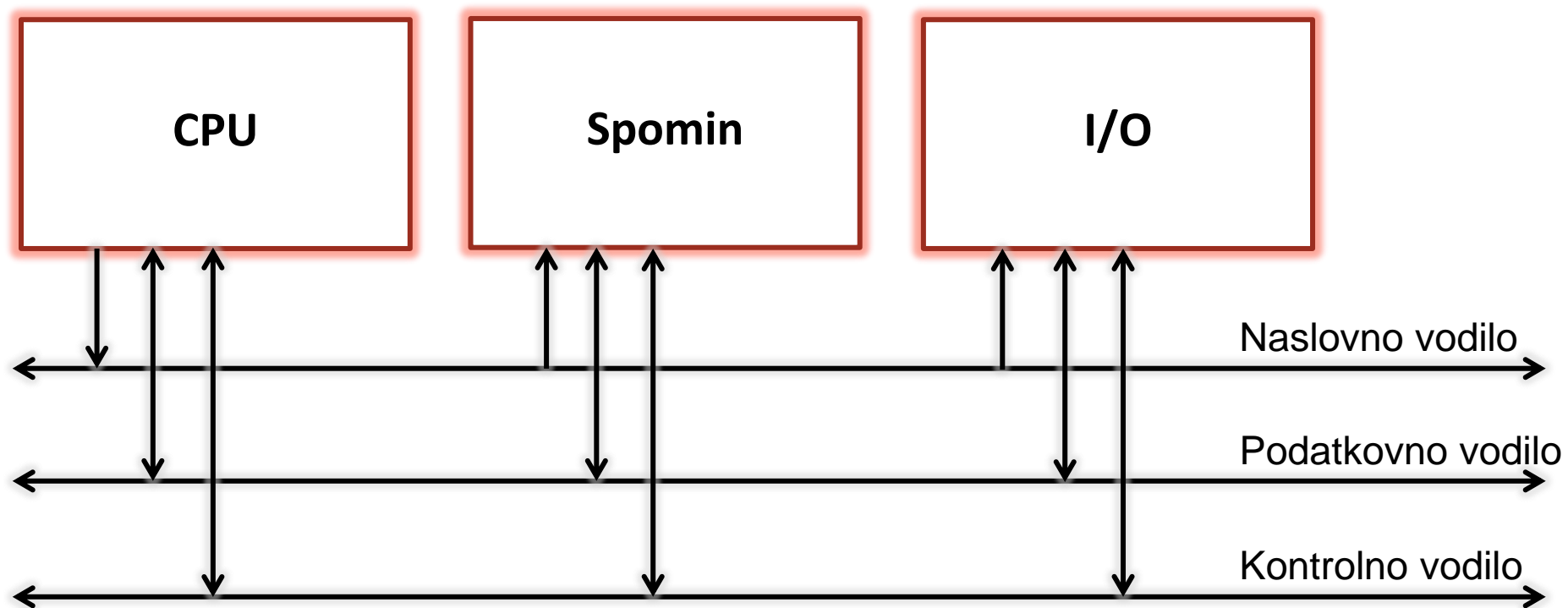
Pregled mikroelektronskih tehnologij

Mikroprocesor (CPU)



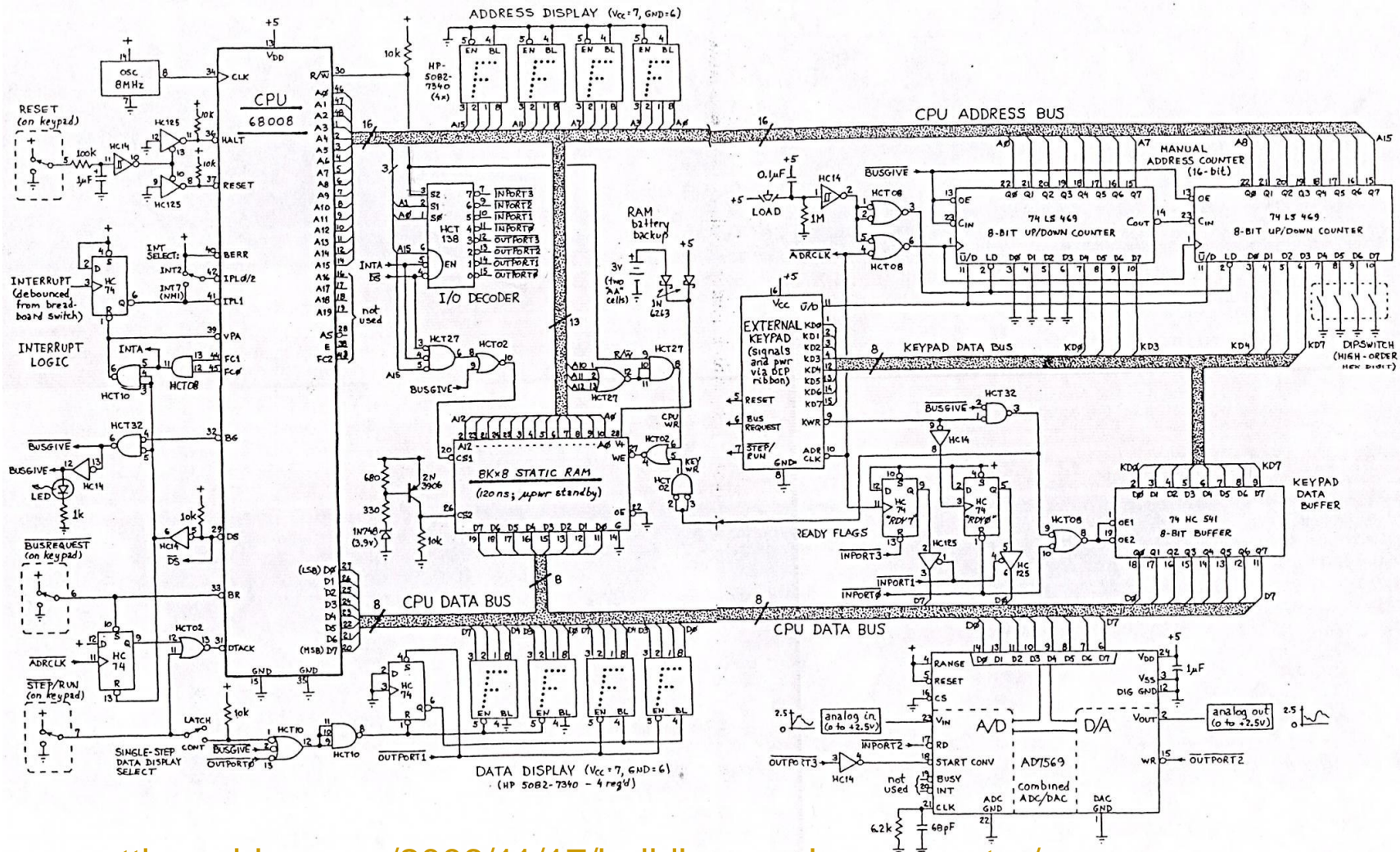
Integrirano vezje, ki sprejema in izvaja kodirane inštrukcije z namenom manipulacije s podatki in kontroliranja vezij, priključenih na vodila.

Mikroračunalnik (MCU)

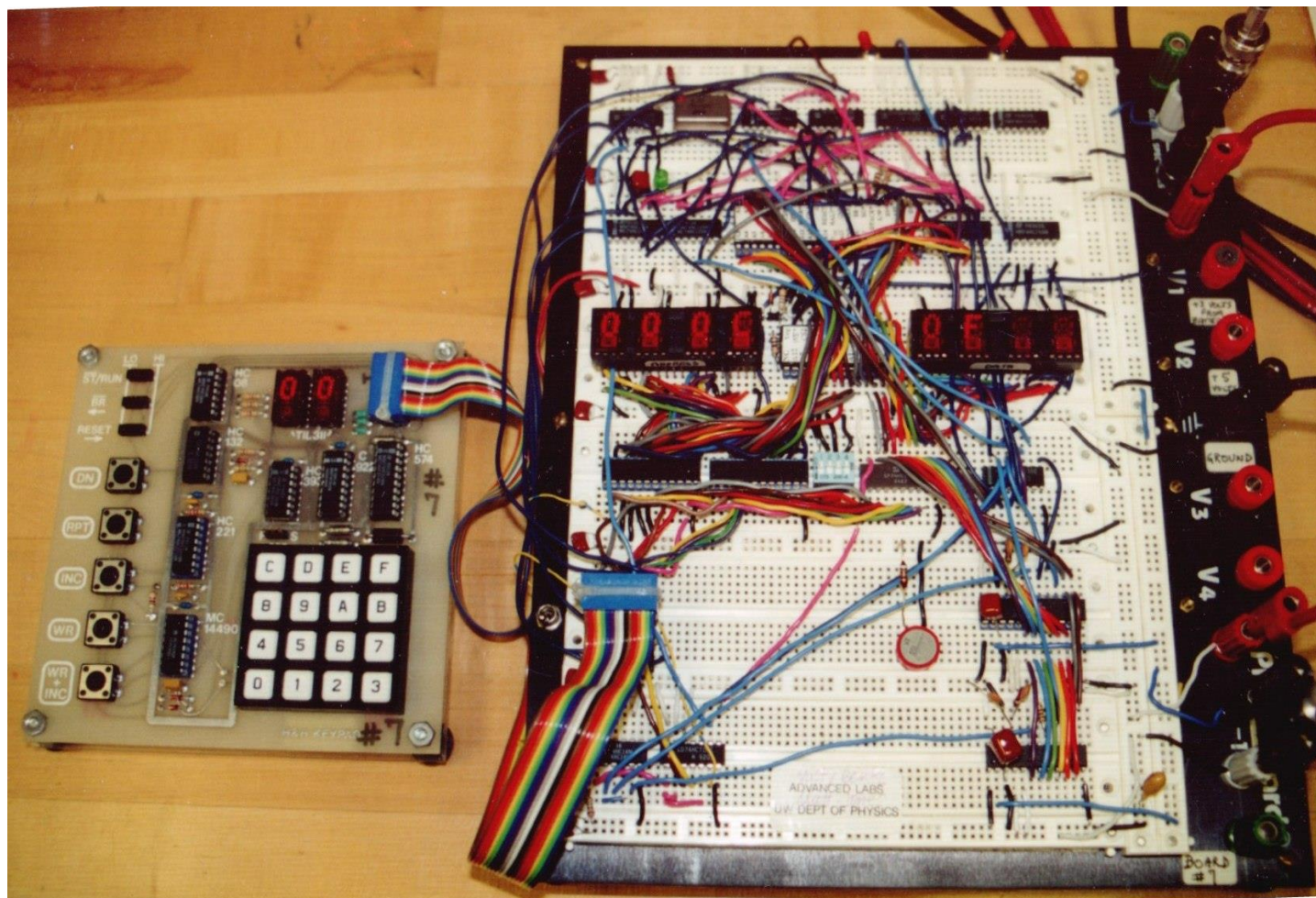


- Je sistem računalniških komponent, povezanih z vodili

Mikroračunalnik



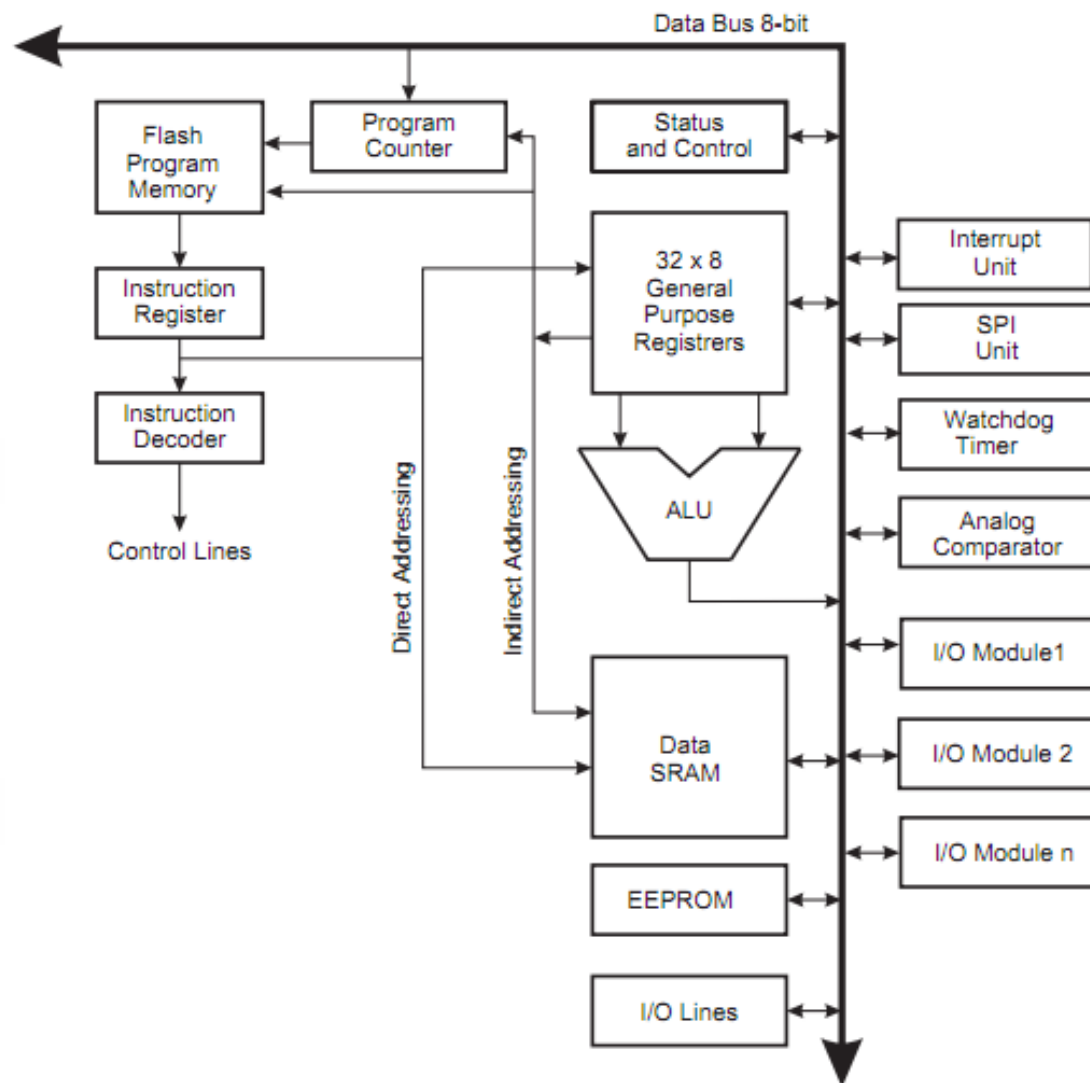
Mikroračunalnik



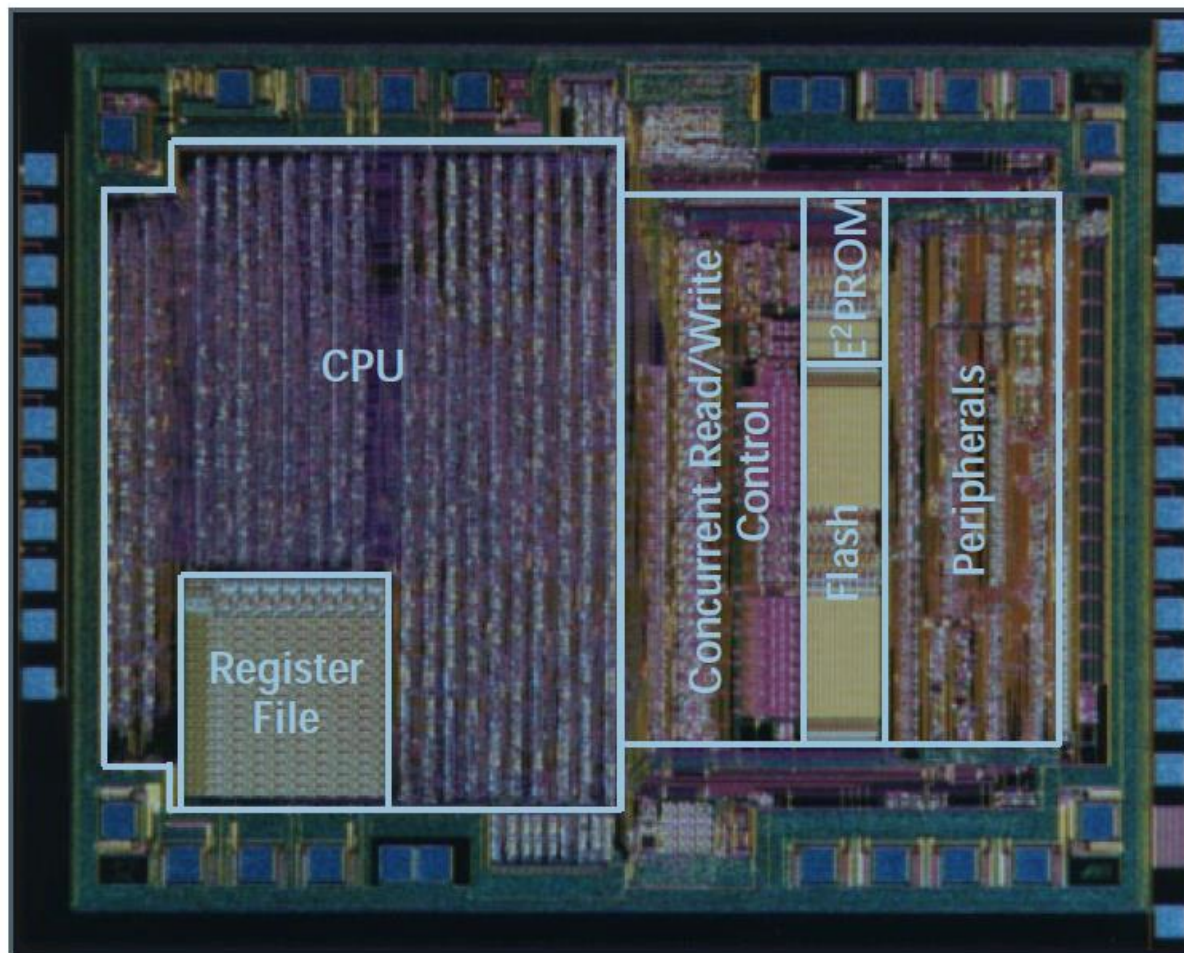
<http://www.mattjonesblog.com/2006/11/17/building-a-microcomputer/>

Mikrokontroler (microcontroller)

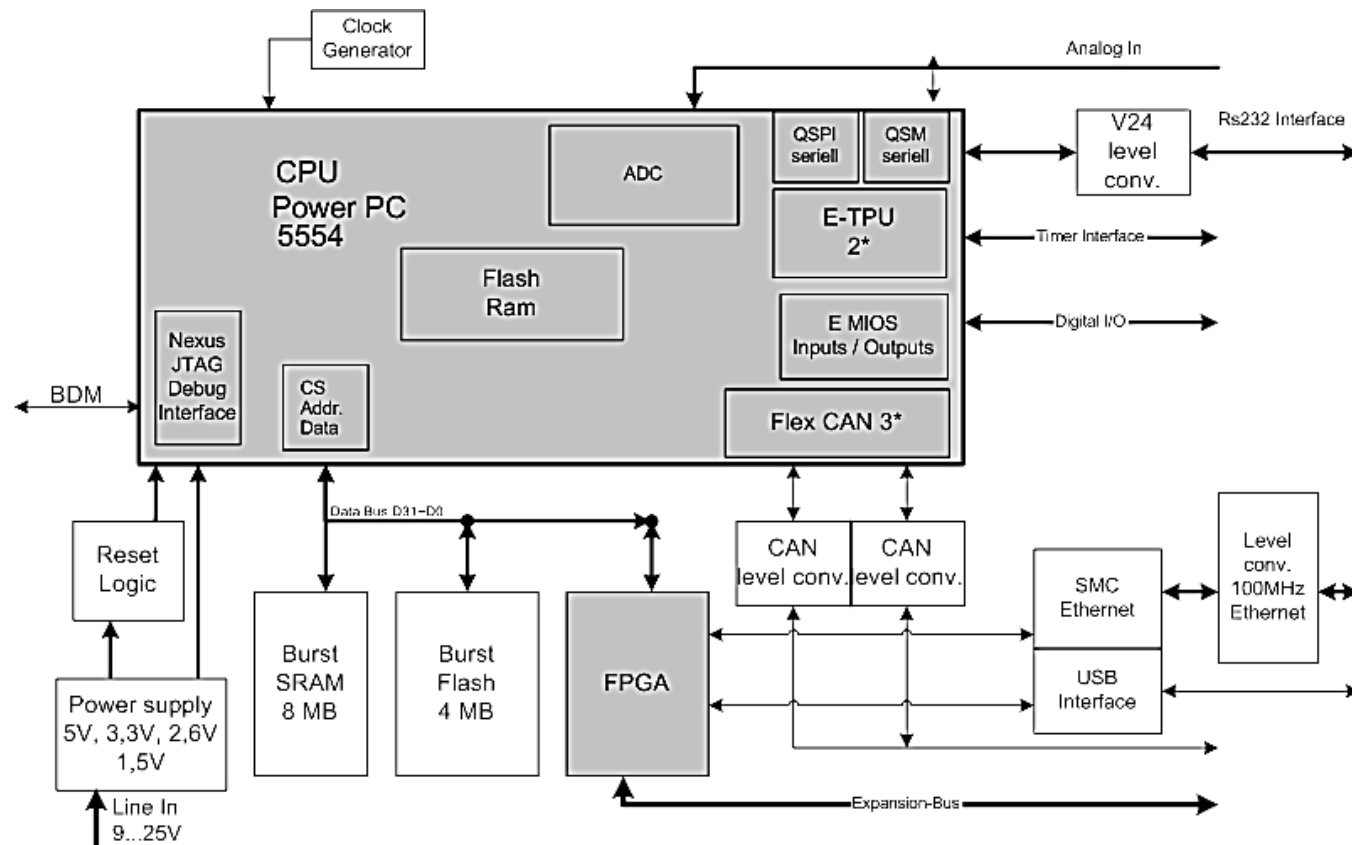
- Mikrokontroler je integriran mikroračunalnik.



Mikrokontroler AT90S1200



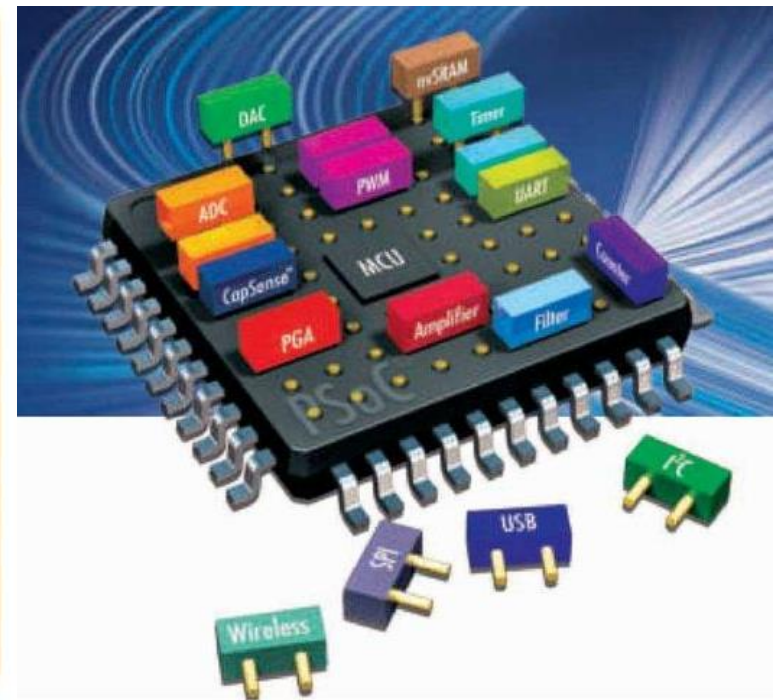
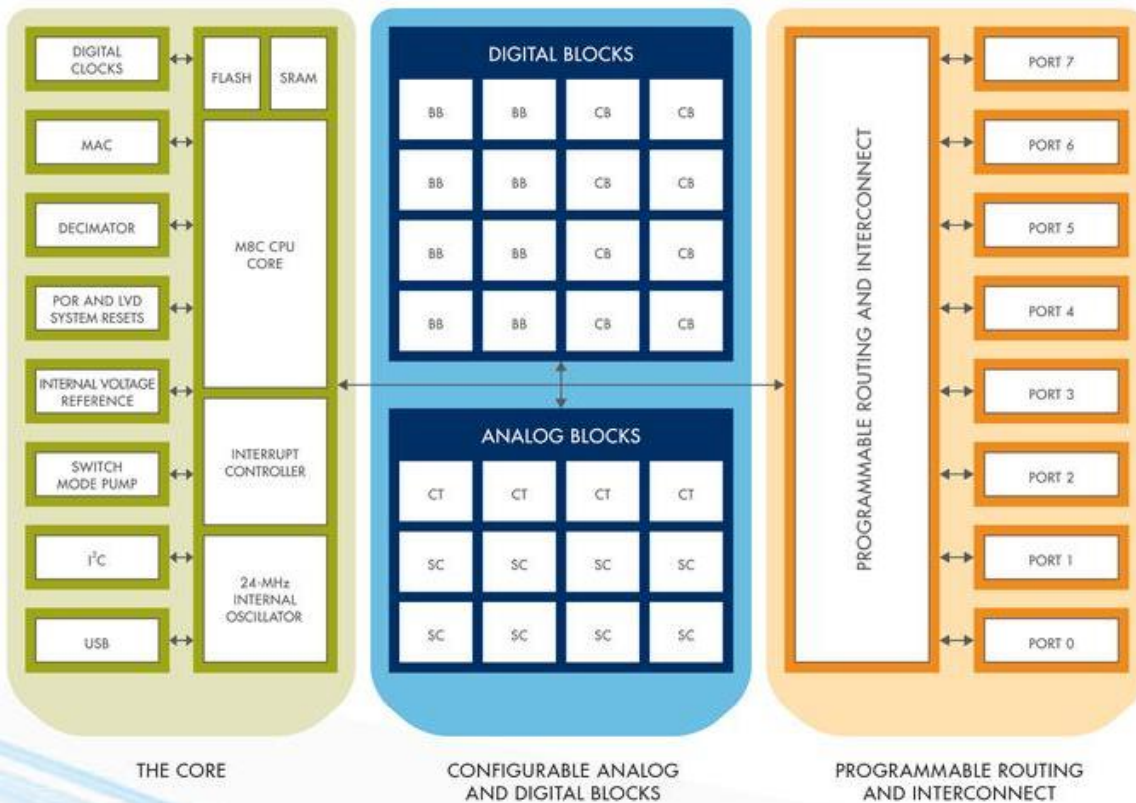
Vgrajeni sistem (embedded system)



Računalniški sistem, ki je zgrajen namensko za opravljanje določene naloge, pogosto za izvajanje v realnem času. Običajno del večjega sistema, ki vključuje tudi druge strojne in mehanske komponente <http://www.eeherald.com/section/design-guide/esmod1.html>

Integrirani sistem (System On Chip)

- Mikrokrmilnik + razni analogni/digitalni bloki skupaj na enem integriranem vezju



Vezje prvega mikroprocesorja INTEL 4004

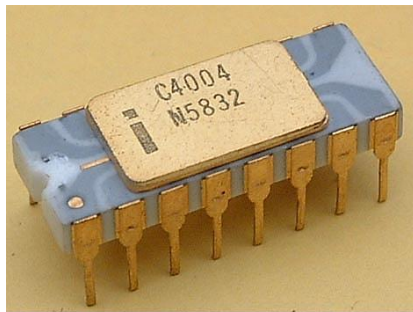
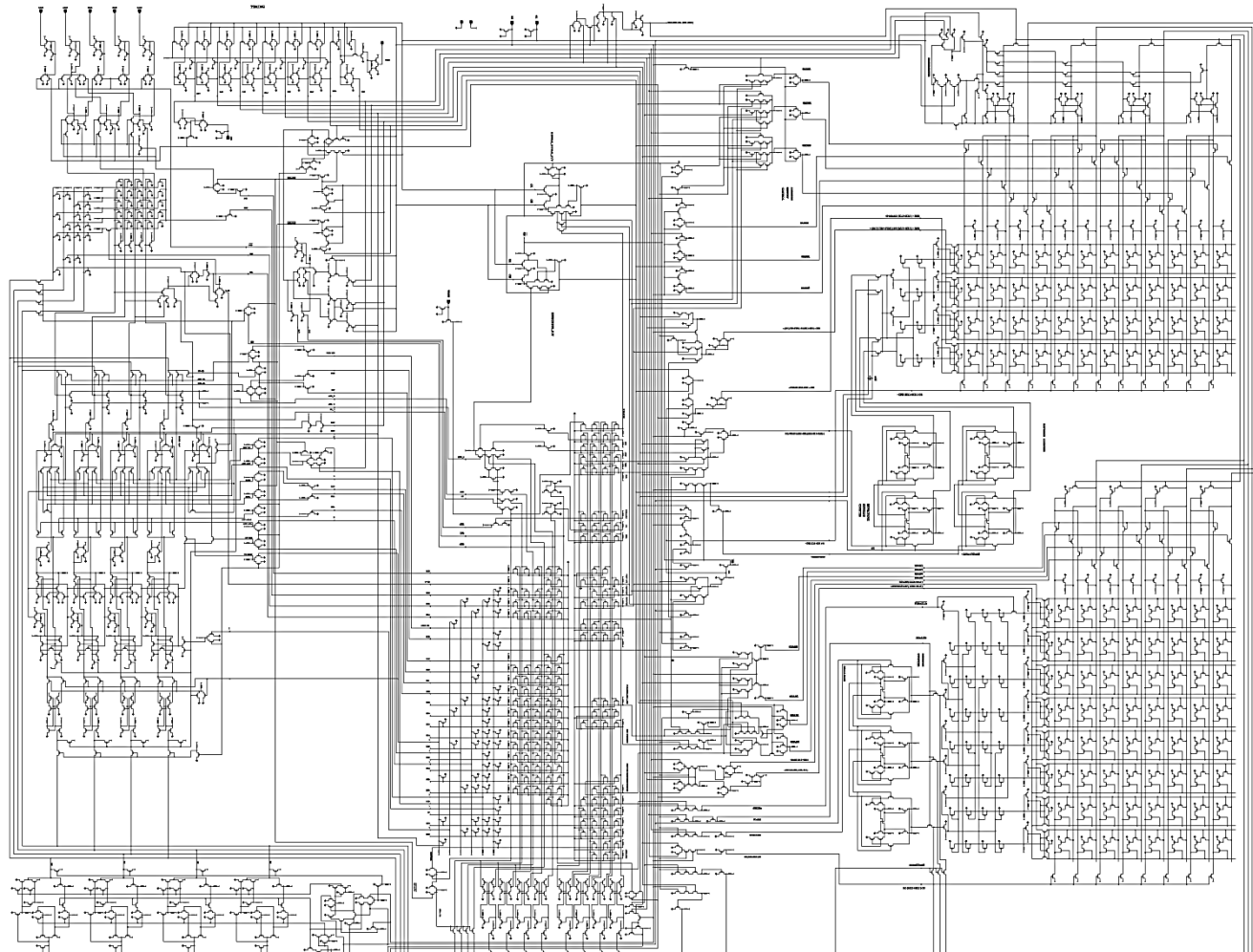


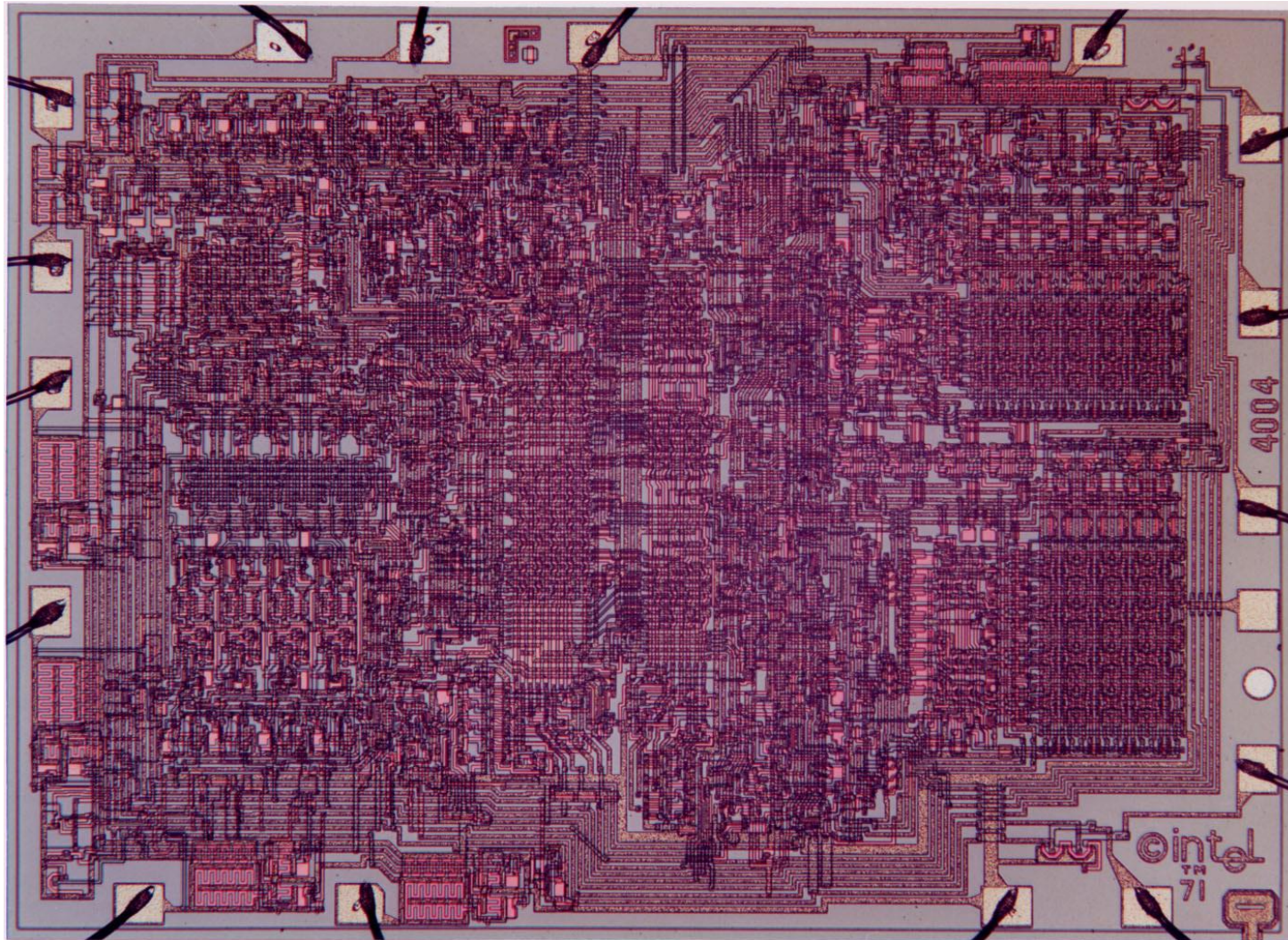
Image courtesy of CPU-Zone.com. Used with permission.



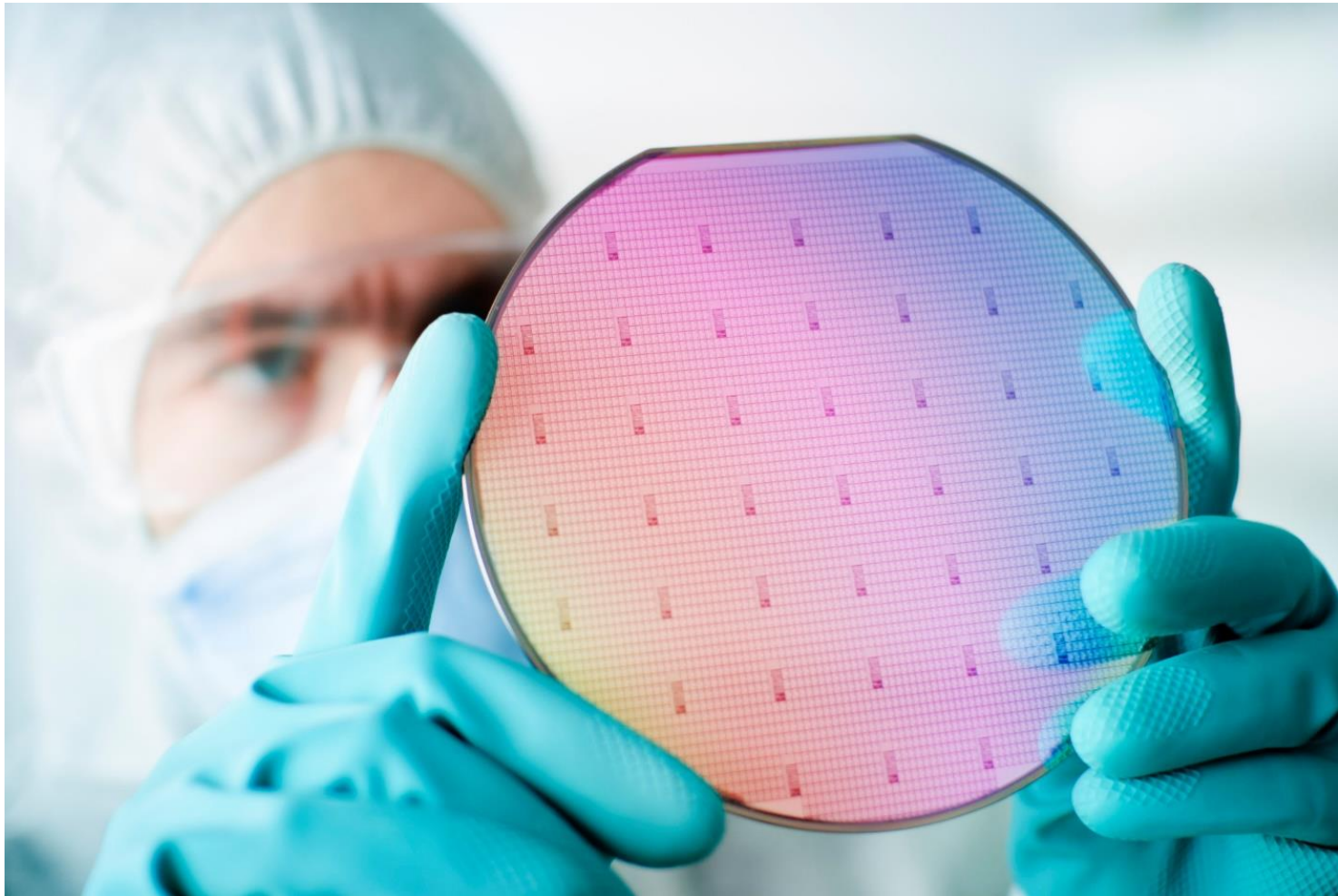
<http://www.intel.com/about/companyinfo/museum/exhibits/4004/docs.htm>

<http://www.cedmagic.com/history/intel-4004.html>

Slika Si rezine INTEL 4004



Silicijeva rezina - wafer



Moorov zakon

Število tranzistorjev v uP se podvoji vsake dve leti.

Moore's Law: The number of transistors on microchips doubles every two years

Moore's law describes the empirical regularity that the number of transistors on integrated circuits doubles approximately every two years. This advancement is important for other aspects of technological progress in computing – such as processing speed or the price of computers.

Our World
in Data

Transistor count

50,000,000,000

10,000,000,000

5,000,000,000

1,000,000,000

500,000,000

100,000,000

50,000,000

10,000,000

5,000,000

1,000,000

500,000

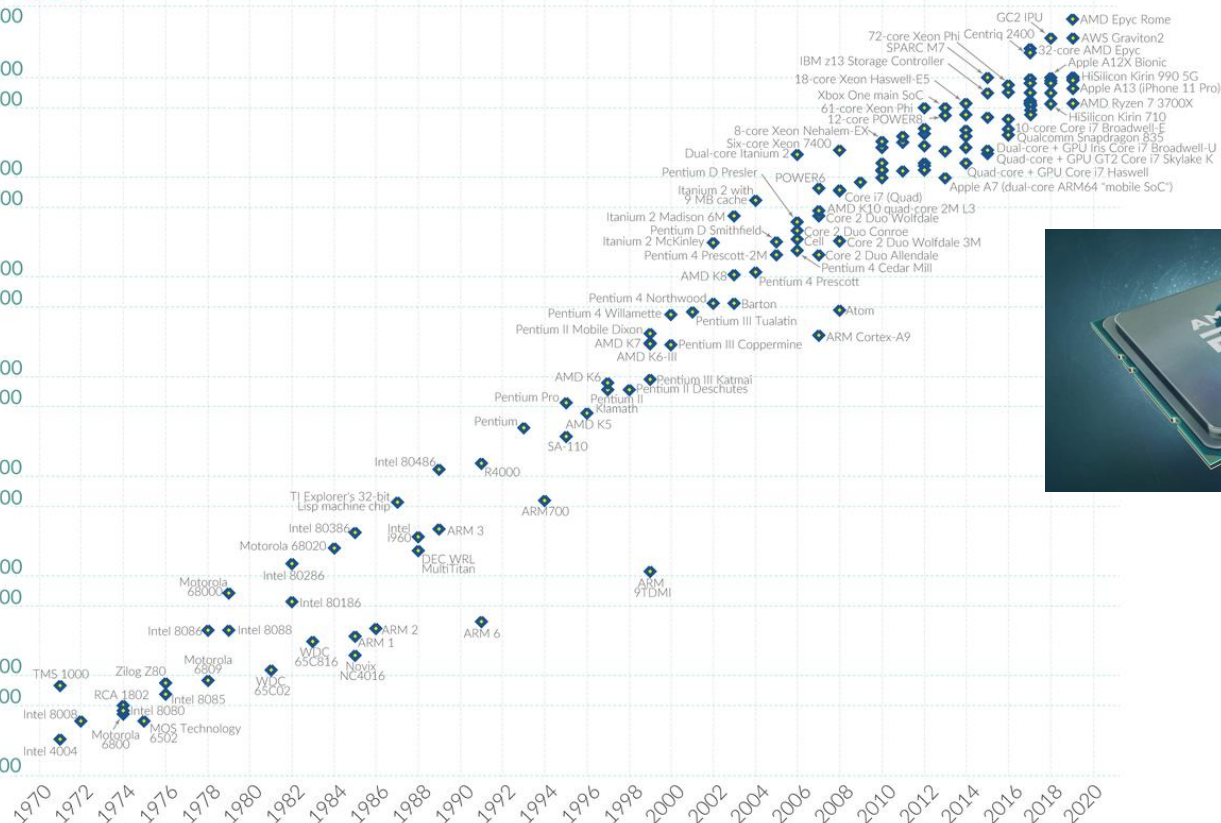
100,000

50,000

10,000

5,000

1,000

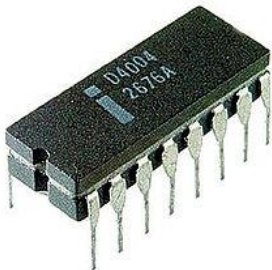


source: Wikipedia (wikipedia.org/wiki/Transistor_count)

/orIdinData.org – Research and data to make progress against the world's largest problems.

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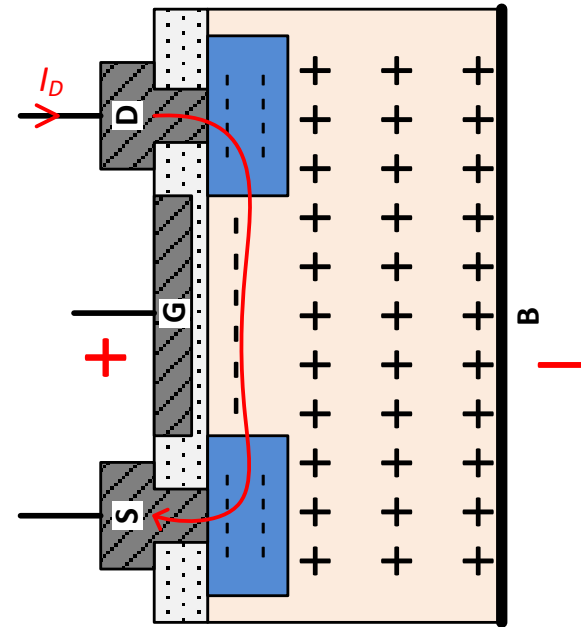
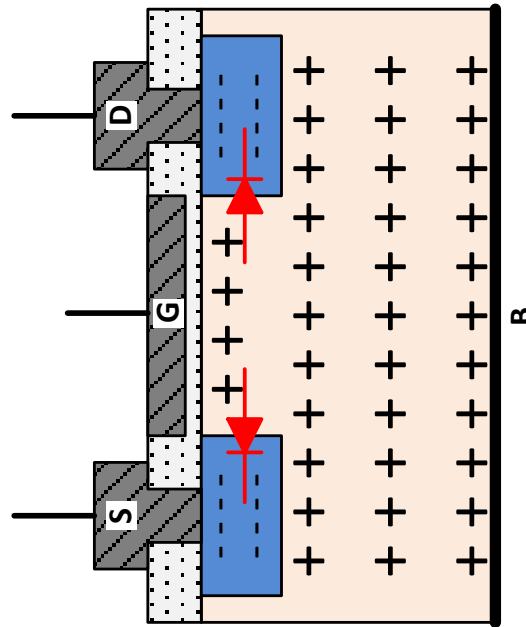
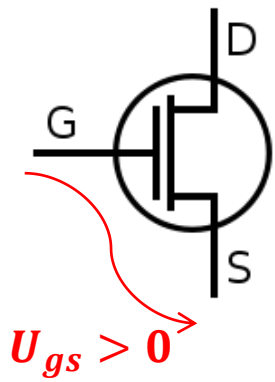
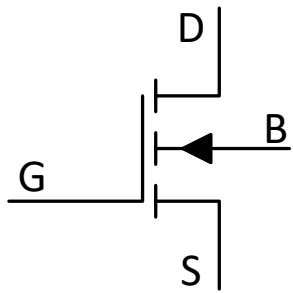
www.wikipedia.org



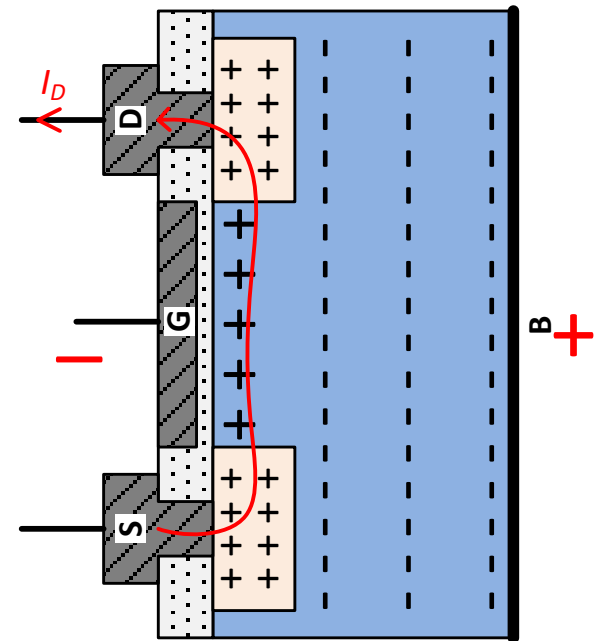
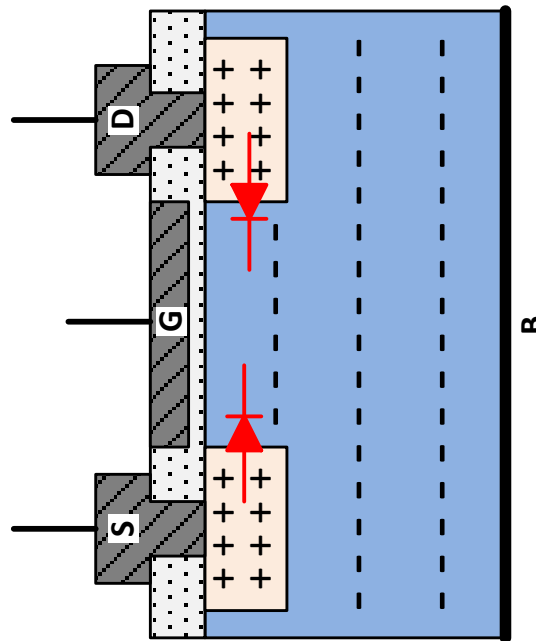
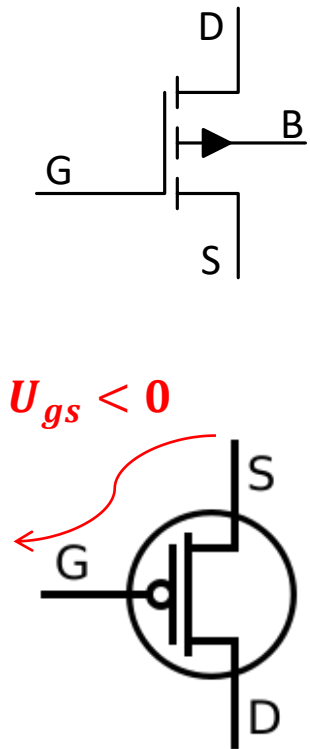
Stopnja integracije

Stopnja integracije		Število elementov	Leto
Zero Scale Integration	ZSI	1	1950
Small Scale Integration	SSI	2-30	1965
Medium Scale Integration	MSI	$30-10^3$	1970
Large Scale Integration	LSI	10^3-10^5	1980
Very Large Scale Integration	VLSI	10^5-10^7	1985
Ultra Large Scale Integration	ULSI	10^7-10^9	1990
Giga- Scale Integration	GSI	10^9-10^{11}	2005
Tera- Scale Integration	TSI	$10^{11}-10^{13}$	2020

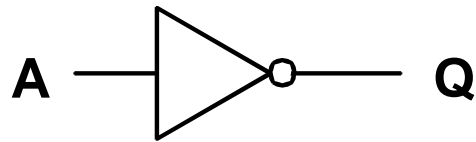
Osnovni element – nMOS tranzistor



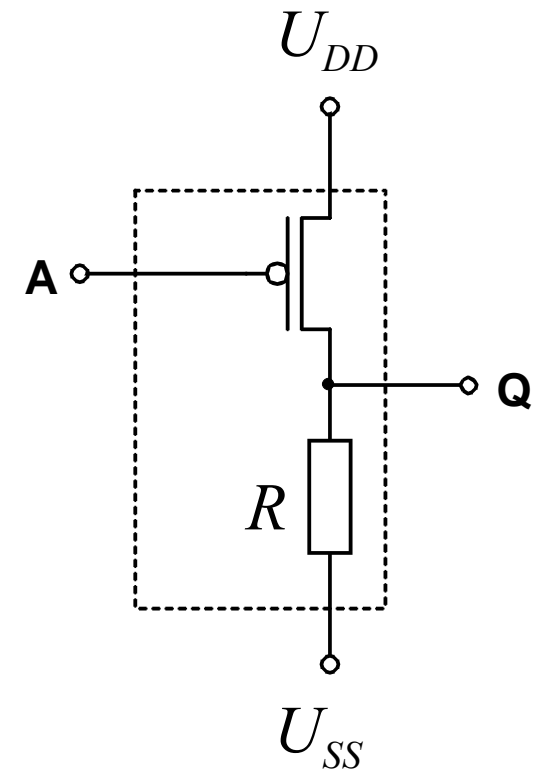
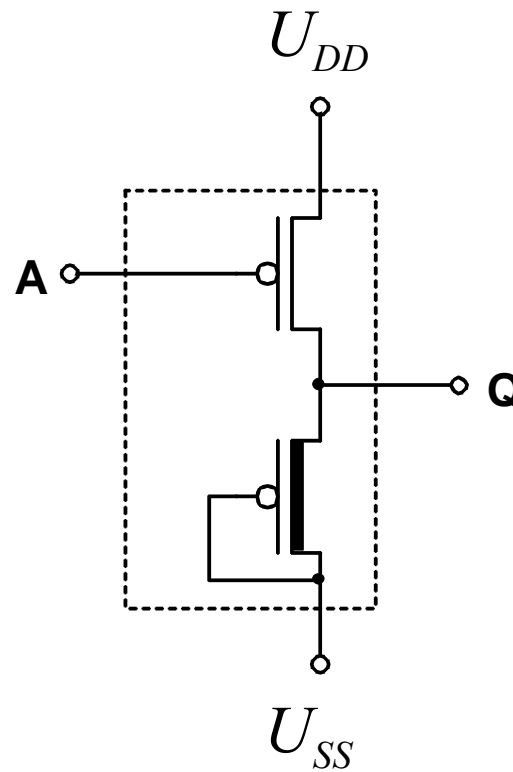
Osnovni element – pMOS tranzistor



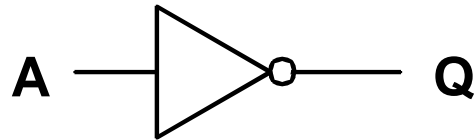
PMOS tehnologija - inverter



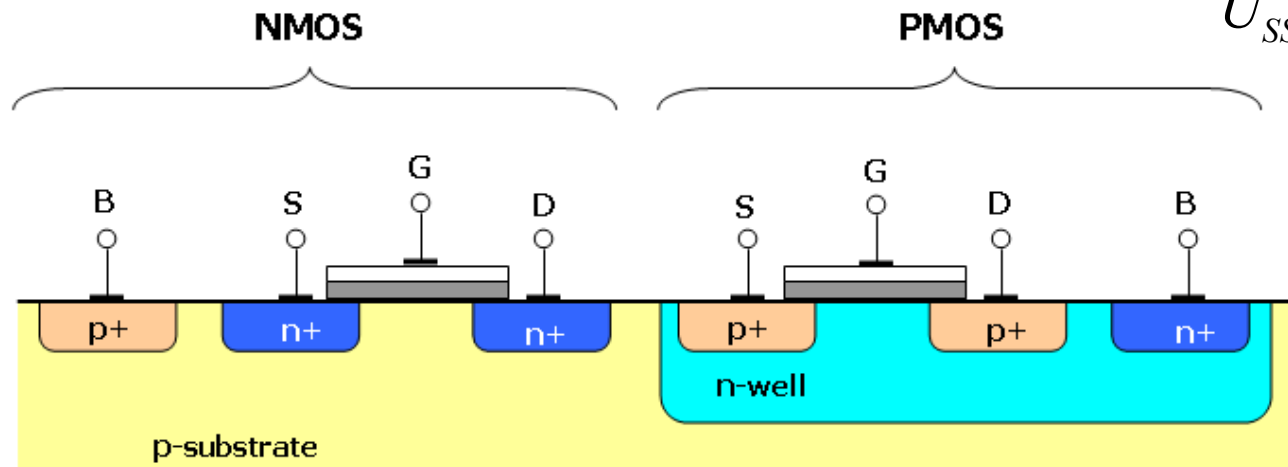
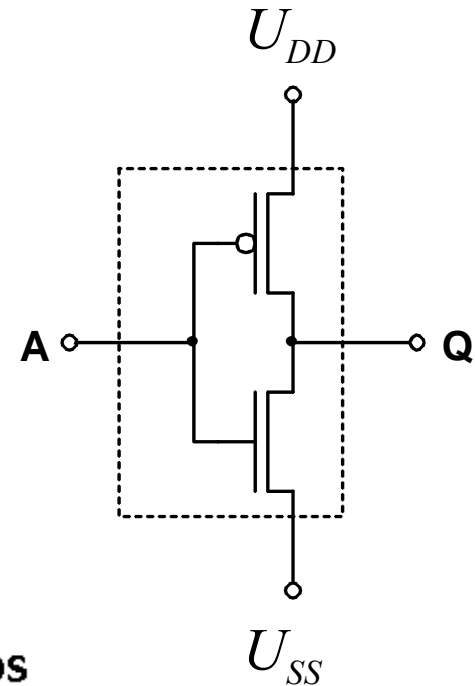
A	Q
0	1
1	0



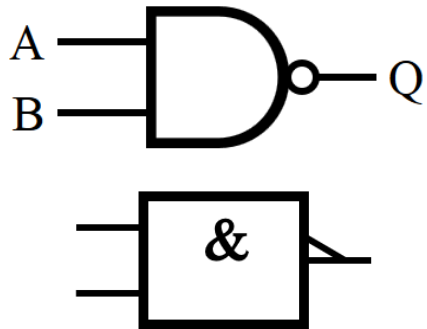
CMOS tehnologija - inverter



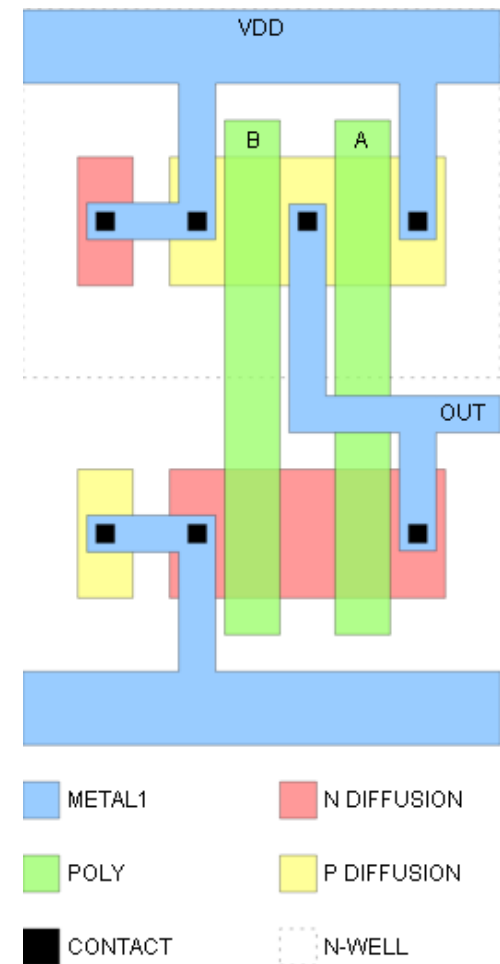
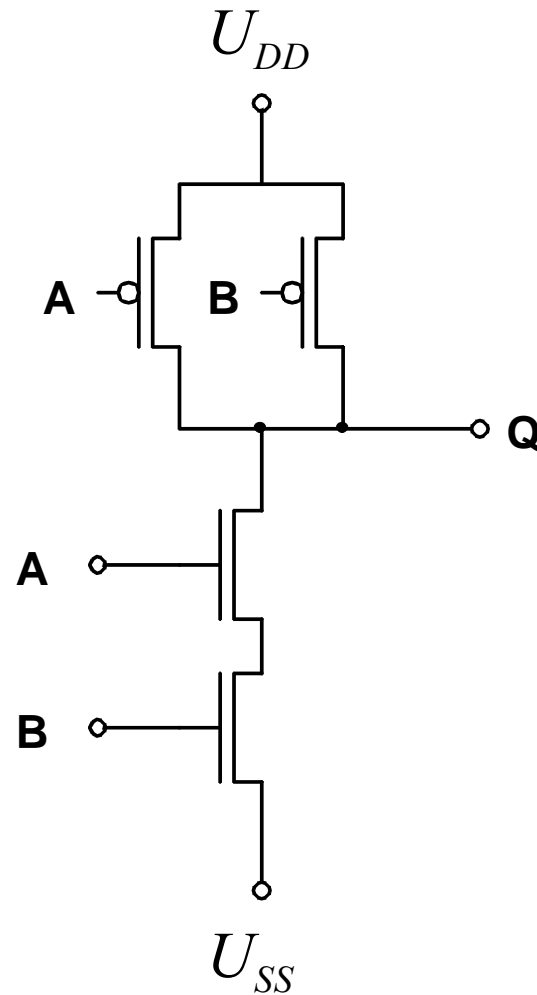
A	Q
0	1
1	0



NE-IN (NAND) vrata



A	B	Q
0	0	1
0	1	1
1	0	1
1	1	0



Tehnologije pomnilnikov

Volatile

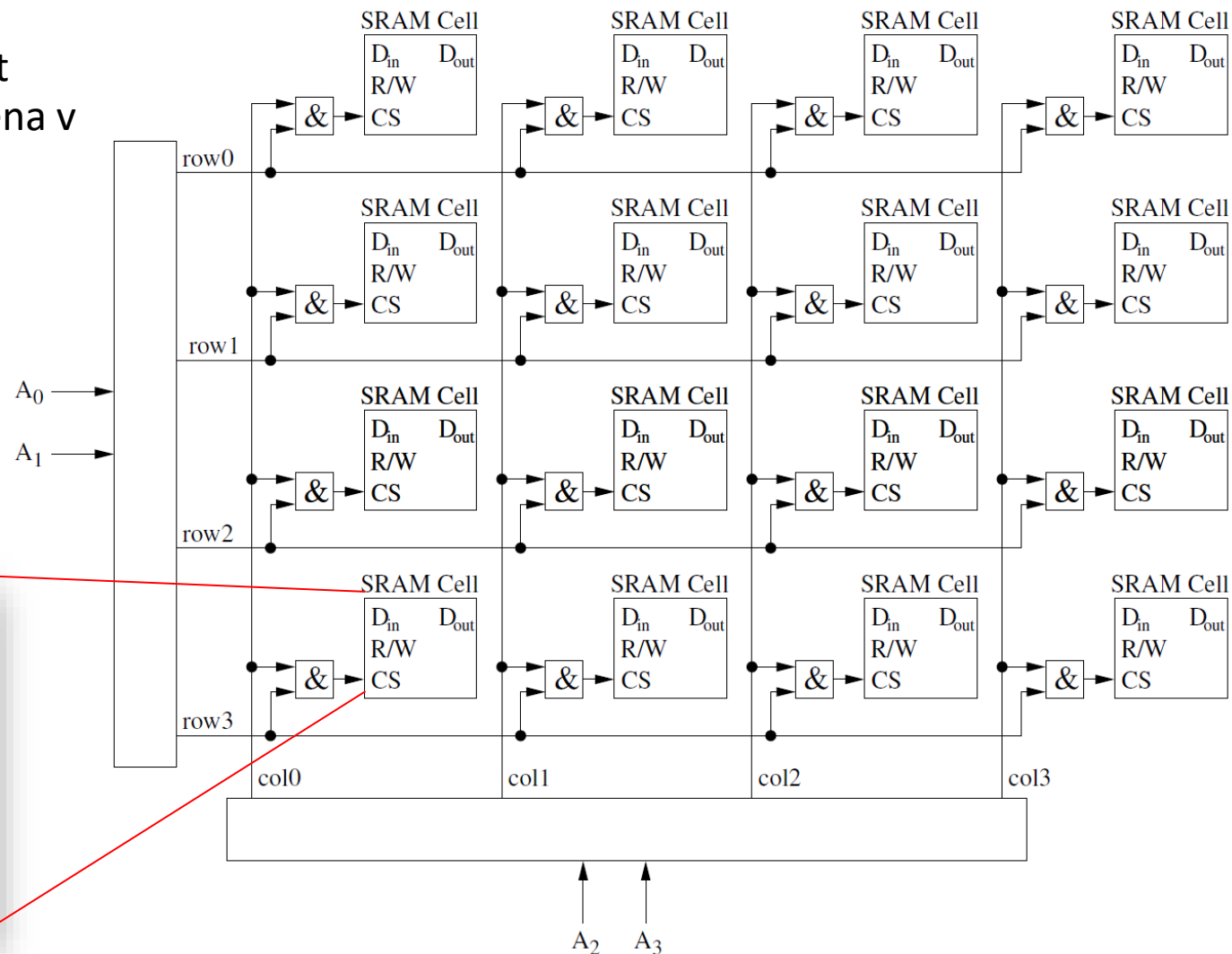
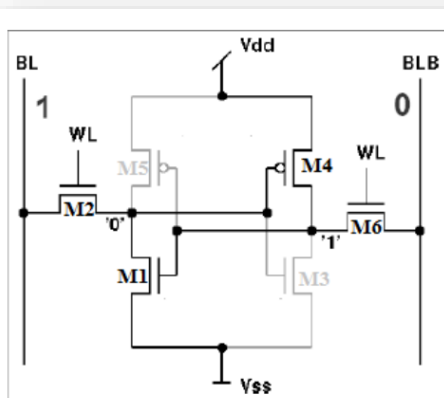
- SRAM
- DRAM

Non-volatile


- ROM
- PROM
- EPROM
- EEPROM
- Flash EEPROM

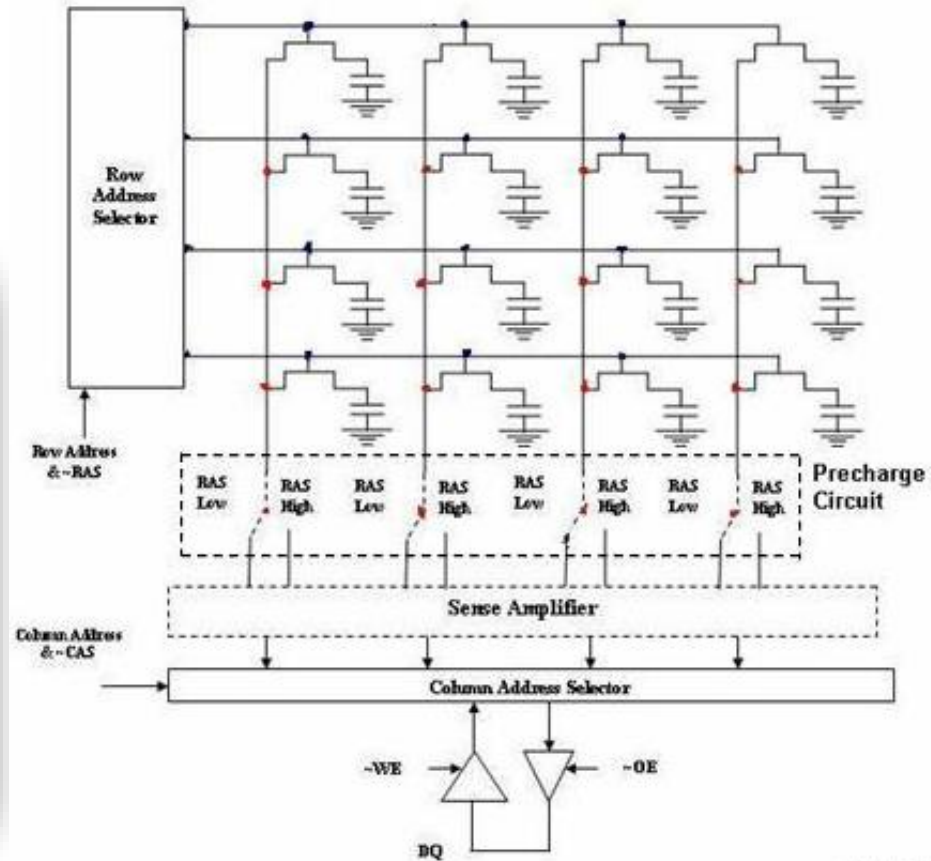
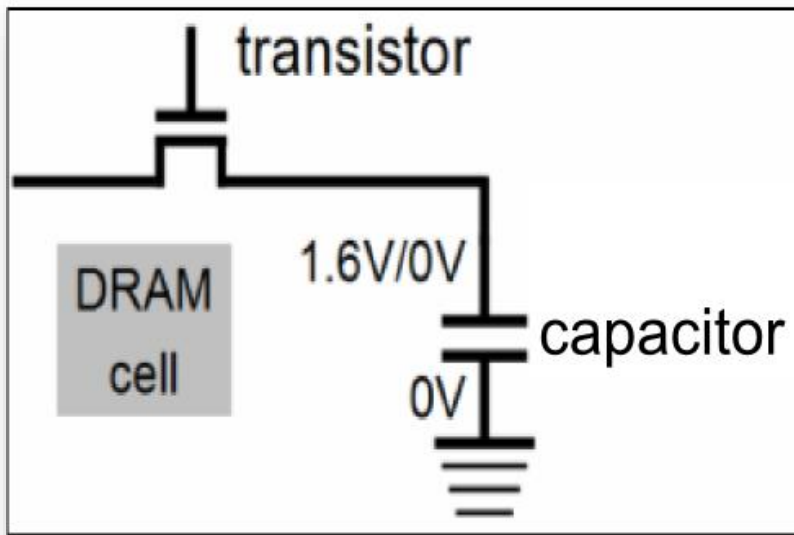
Statični ram: SRAM

- 6 tranzistorjev za 1 bit
- Informacija je shranjena v logičnem stanju FF
- Najhitrejši pomnilnik
 - registri
 - delovni pomnilnik

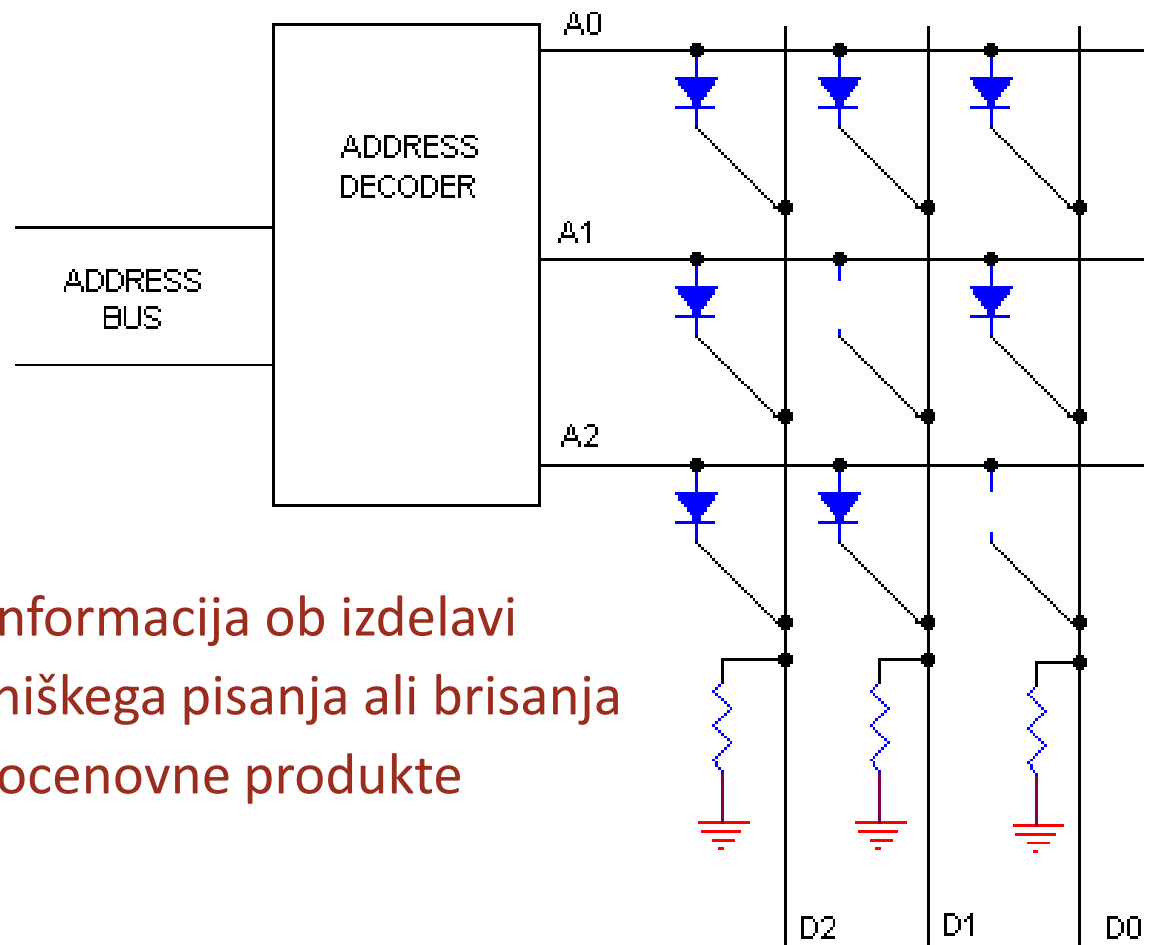


Dinamični RAM

- DRAM – 1 tranzistor za 1 bit
 - Informacija se shrani v kondenzatorju – osveževanje!!
 - Najvišja gostota
 - Najnižja cena
- 

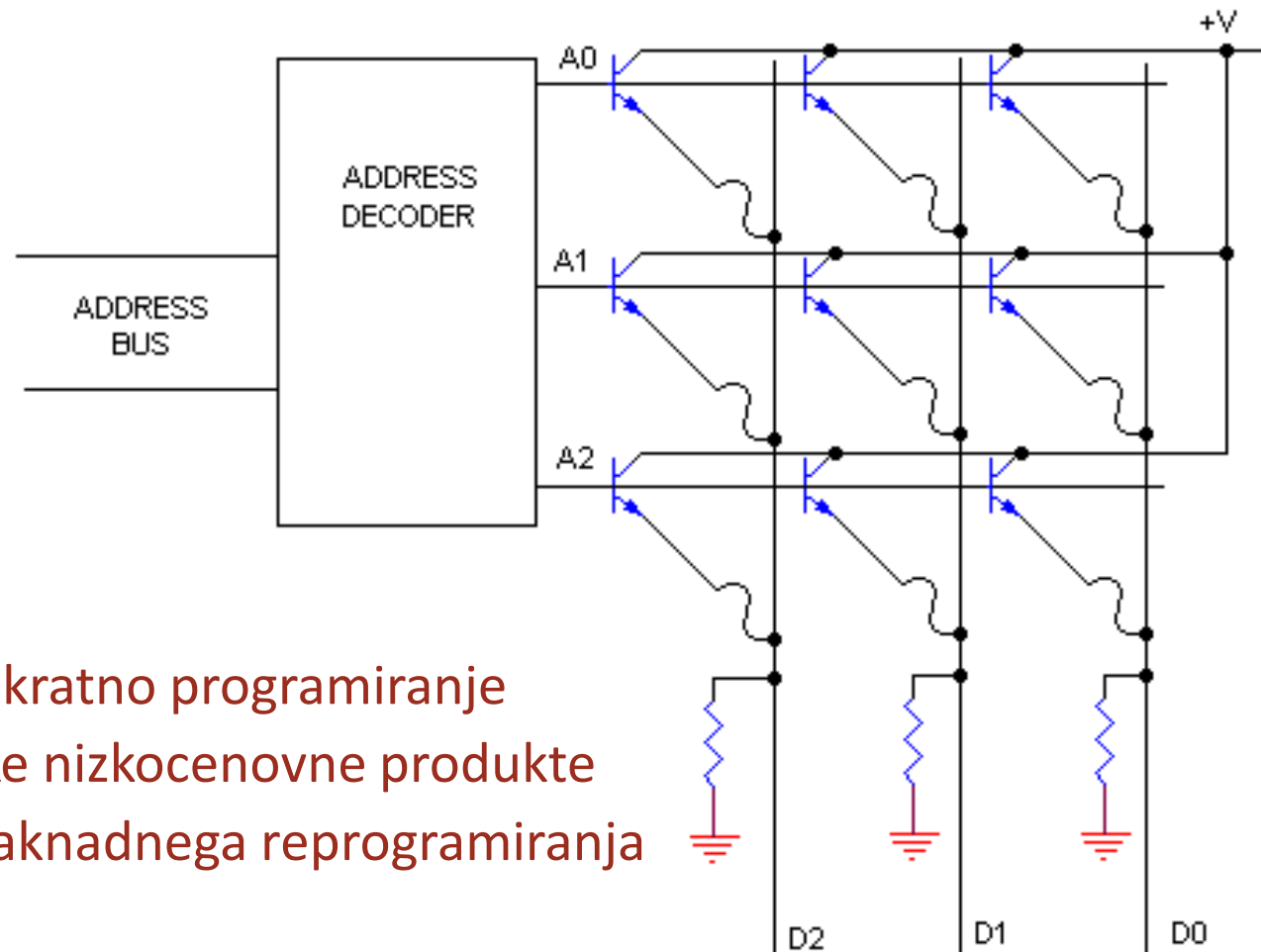


ROM – Read Only Memory



- Tovarniško vnesena informacija ob izdelavi
- Ne omogoča uporabniškega pisanja ali brisanja
- Za velikoserijske nizkocenovne produkte

PROM – Programabilni ROM



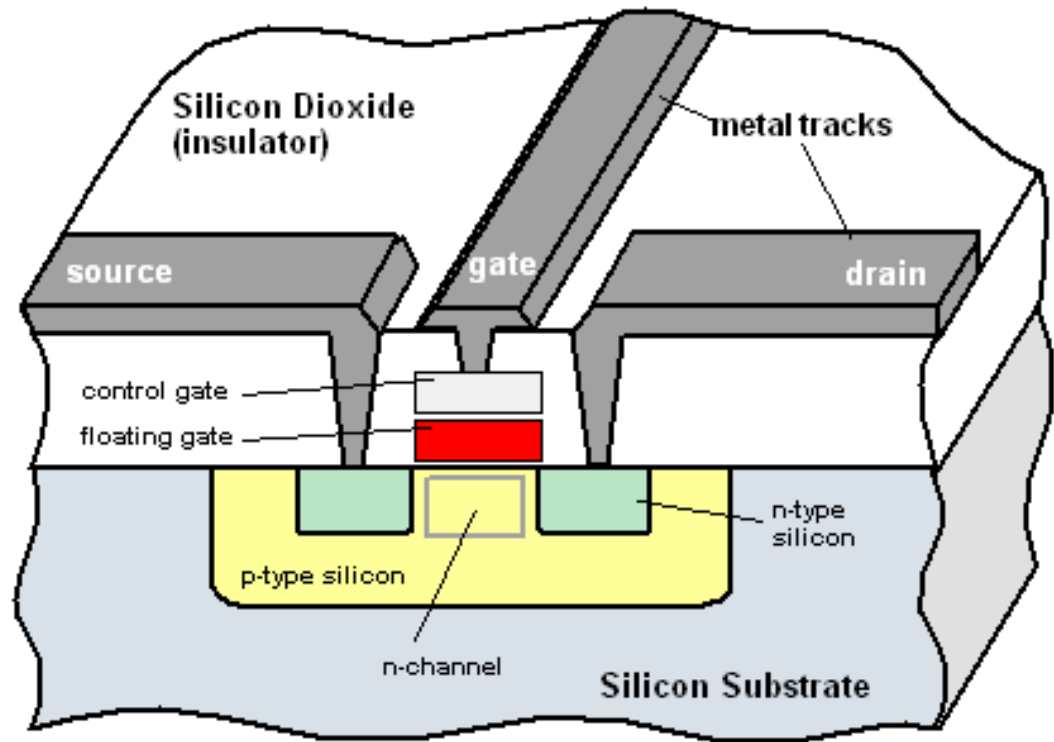
- Omogoča le enkratno programiranje
- Za velikoserijske nizkocenovne produkte
- Ne omogoča naknadnega reprogramiranja

MOS tranzistor z dodatnimi plavajočimi vrati

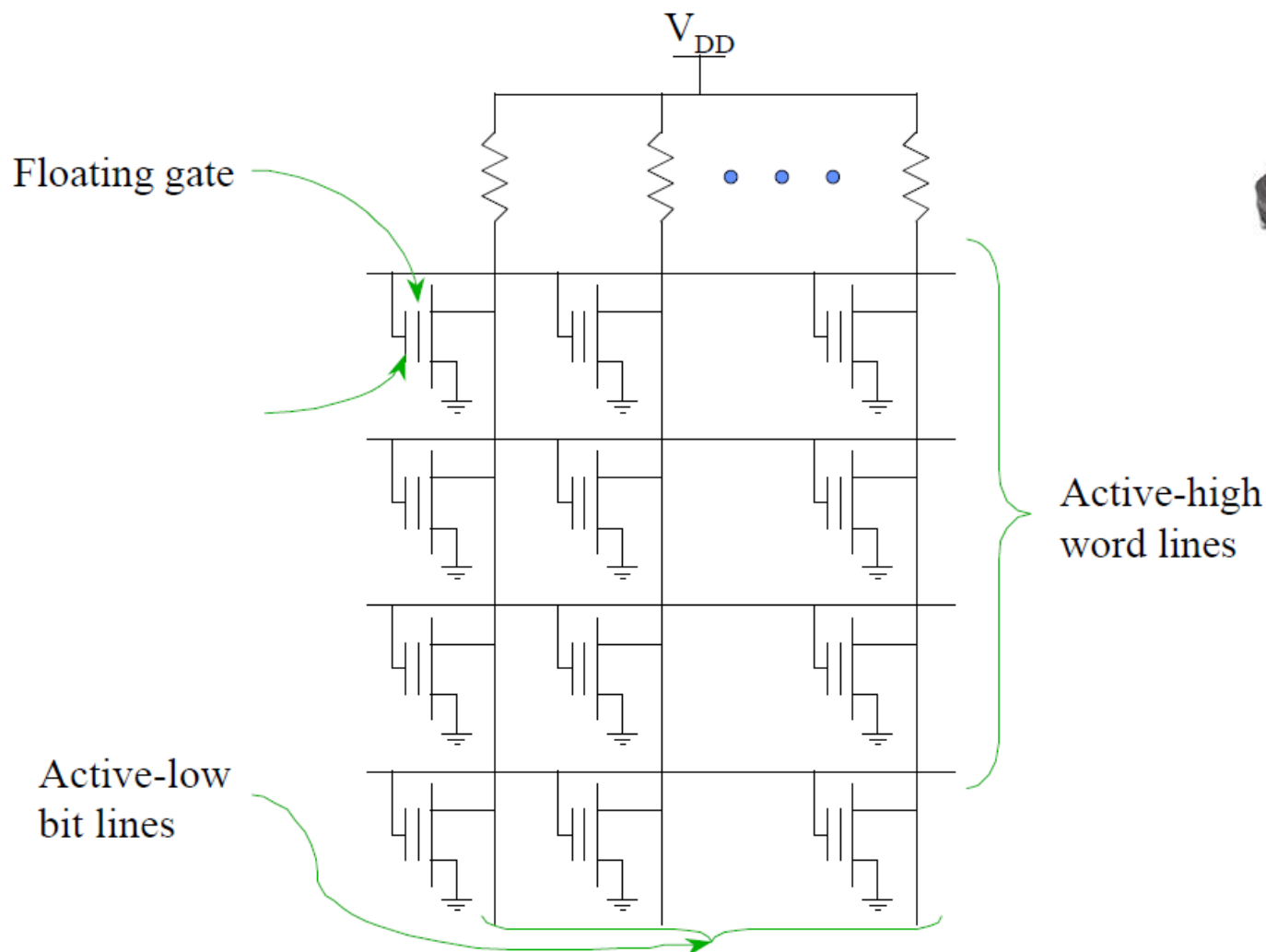
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- Naboj pri vpisu tunelira k plavajočim vratom
- Brisanje
 - UV svetloba (EPROM)
 - Prenos naboja v obratni smeri (EEPROM, Flash)
- Spremeni se pragovna napetost U_T
- Kompleksna kontrolna logika
 - visoka cena

EEPROM and Flash Transistor



EPROM, EEPROM in Flash



EPROM



EEPROM, Flash

EEPROM in FLASH

- **EEPROM**

- Vsako celico je mogoče vpisati ali izbrisati posebej
- ~ 100 000 ciklov brisanja/pisanja
- Drag, nižja gostota
- Trajno hranjenje konstant

- **FLASH**

- Brisanje le po blokih
- Zelo poenostavljena kontrolna logika
- Najvišja gostota informacije na enoto površine in najnižja cena
- Čeprav ni mogoče brisati po celicah, je primeren za programski pomnilnik
- Dodatno znižanje cene
 - nižje število ciklov brisanja/pisanja: 1000 - 10 000 ciklov
- Hranjenje programske kode

Študenti naj bi znali:

- Pojasniti razlike med mikroprocesorjem, mikroračunalnikom, mikrokrmilnikom, vgrajenim in integriranim sistemom
- Opisati Moorov zakon in njegove posledice.
- Razložiti delovanje p - in n - kanalnega MOS tranzistorja, p -MOS in CMOS tehnologije logičnih vrat.
- Primerjati glavne lastnosti pomnilniških tehnologij iz stališča
 - možnosti branja/pisanja/brisanja
 - hranjenje informacij
 - hitrosti
 - gostote shranjene informacije
 - področja uporabe
 - cene

Literatura/Literature

knjiga/ povezava book/ link	poglavje/ chapter
<u>Prvi intelov procesor 4004</u>	
<u>Intel chips timeline</u>	
<u>Sandpile.org (internet database of microprocessors)</u>	
<u>Computer Architecture, A quantitative approach</u>	1.1, 1.4-1.6, 1.12