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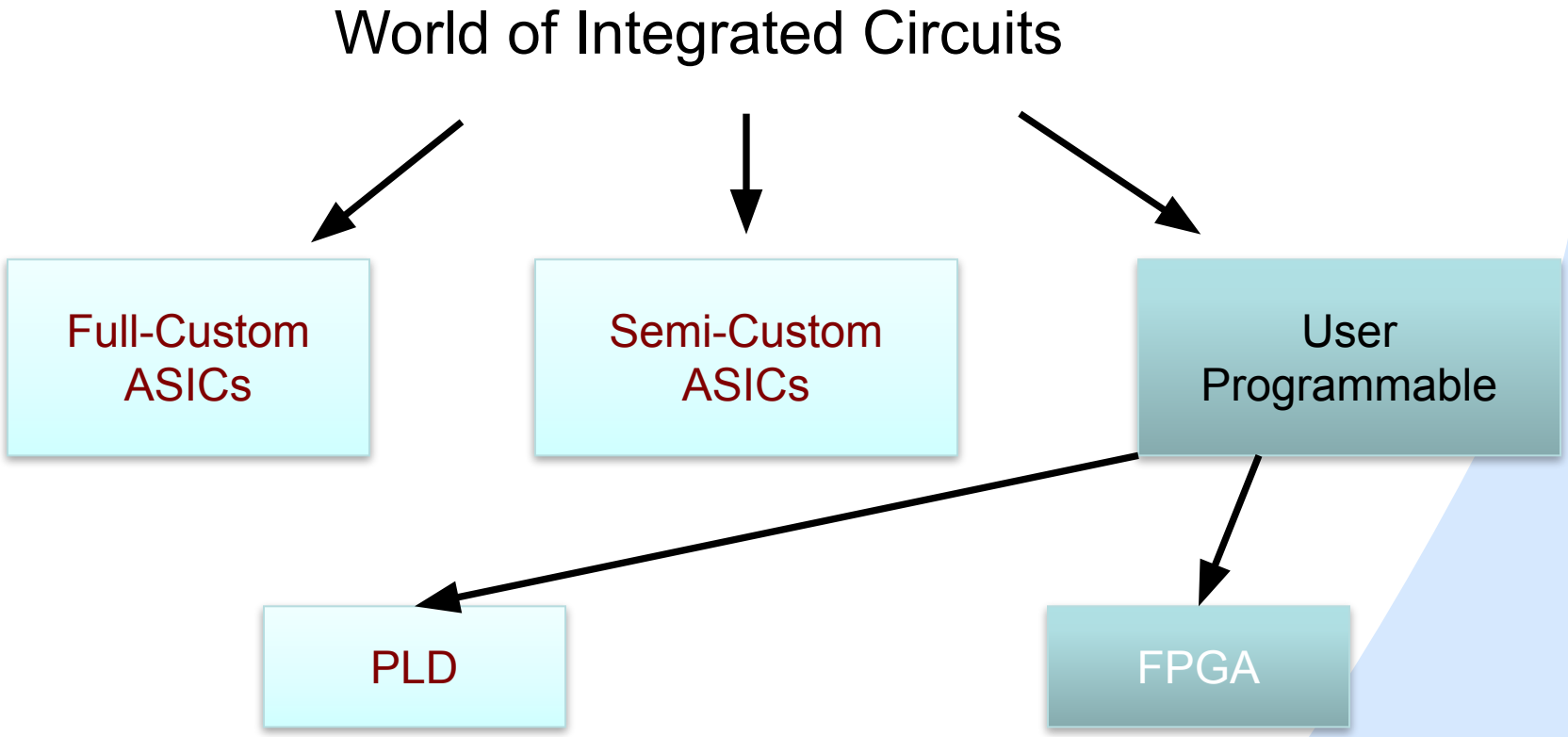
КАИ

FIELD PROGRAMMABLE GATE ARRAYS

Introduction

What is a FPGA



Field programmable gate arrays (FPGAs) – are digital integrated circuits that contain configurable blocks of logic along with configurable interconnects between these blocks.

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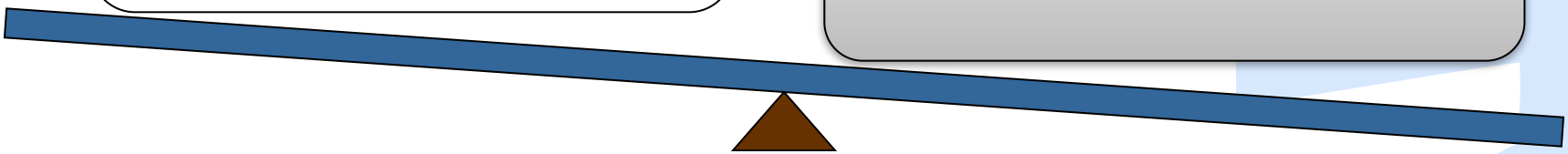
Why do we need FPGAs?

ASICs

- High performance
- Low power
- Low cost in high volumes

FPGAs

- Low development cost
- Short time to market
- Reprogrammable



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Other FPGA advantages

- Manufacturing cycle for ASIC is very costly, lengthy and engages lots of manpower
- Mistakes not detected at design time have large impact on development time and cost
- FPGAs are perfect for rapid prototyping of digital circuits
- Easy upgrades like in case of software
- Unique applications

Architecture of FPGA

The architecture of FPGA is very simple than other programmable devices

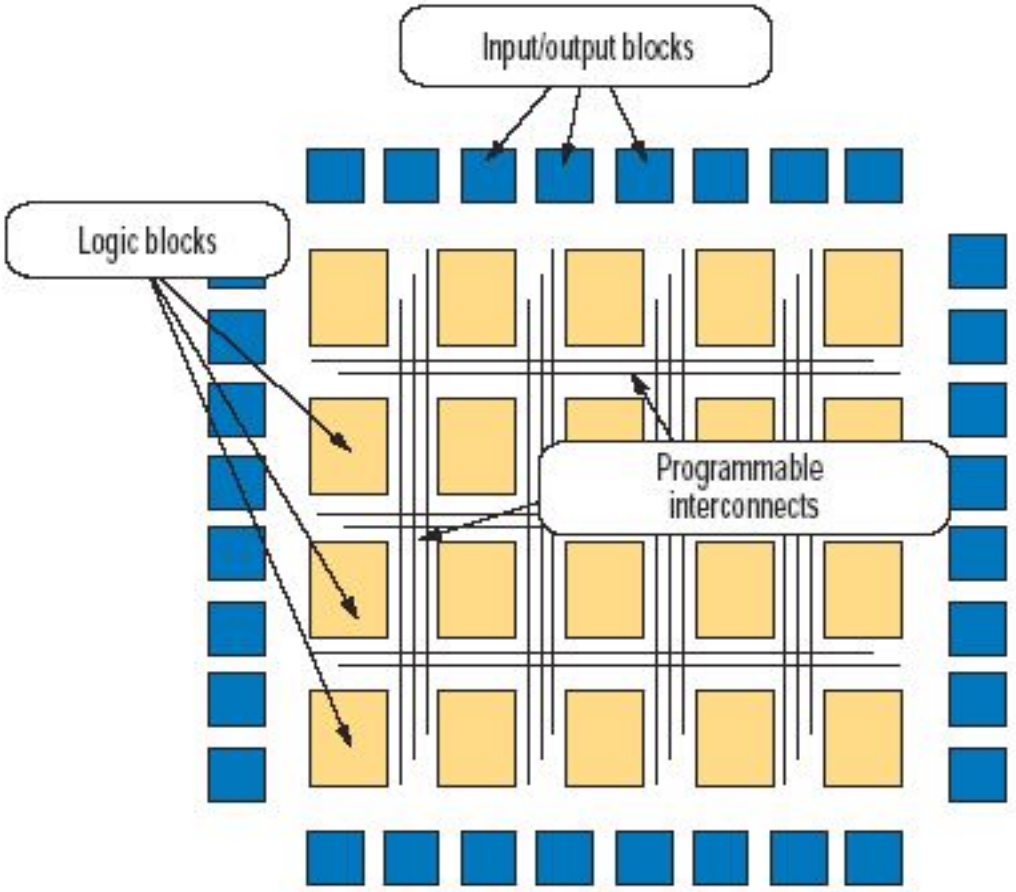
Elements of FPGA

The basic elements of an Field Programmable Gate Array are:

- Configurable logic blocks(CLBs)
- Configurable input output blocks(IOBs)
- Two layer metal network of vertical and horizontal lines for interconnecting the CLBS and FPGAs (programmable interconnect)

Architecture of FPGA

A simple modern architecture of FPGA is shown below:



All FPGAs include a regular, programmable, and flexible architecture of logic blocks surrounded by input/output blocks on the perimeter. These functional blocks are linked together by a hierarchy of highly versatile programmable interconnects.

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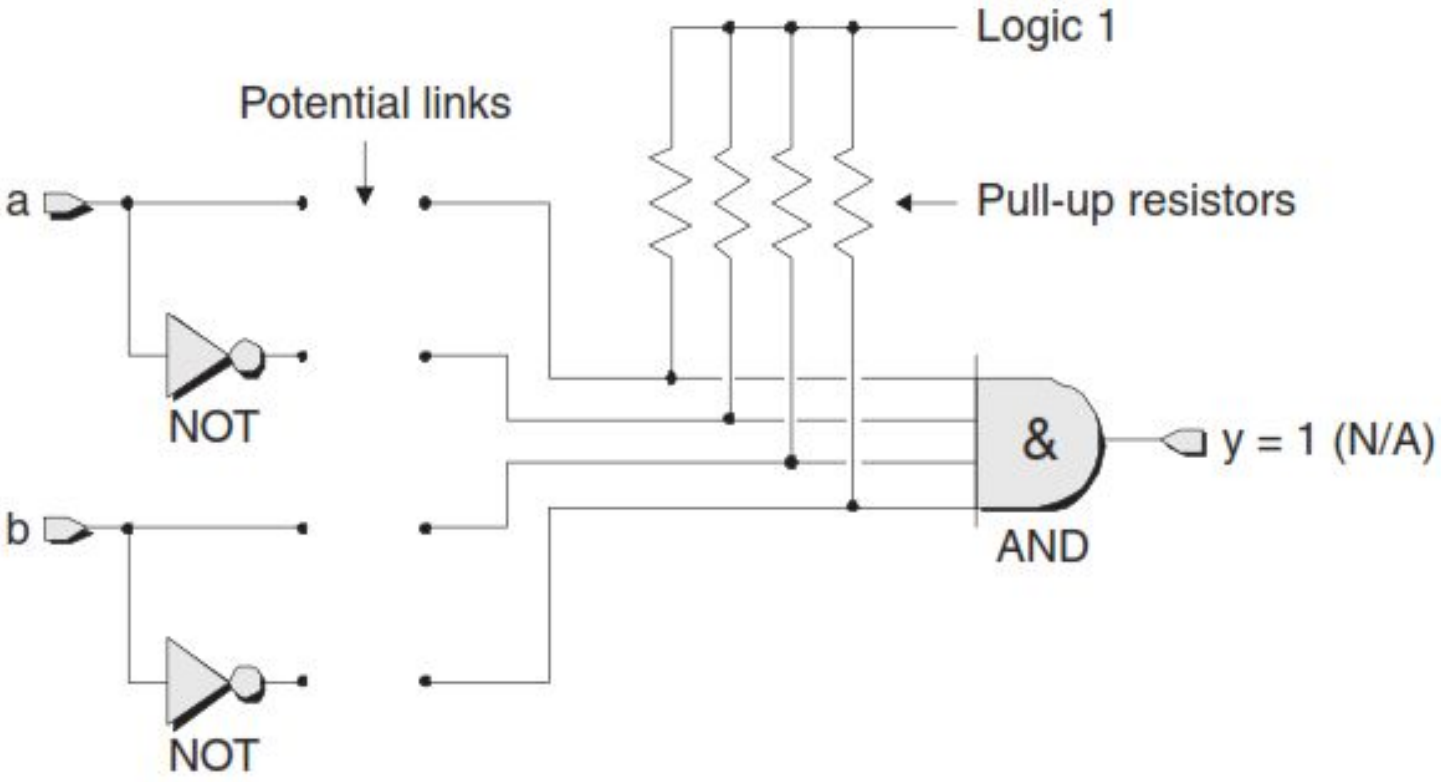
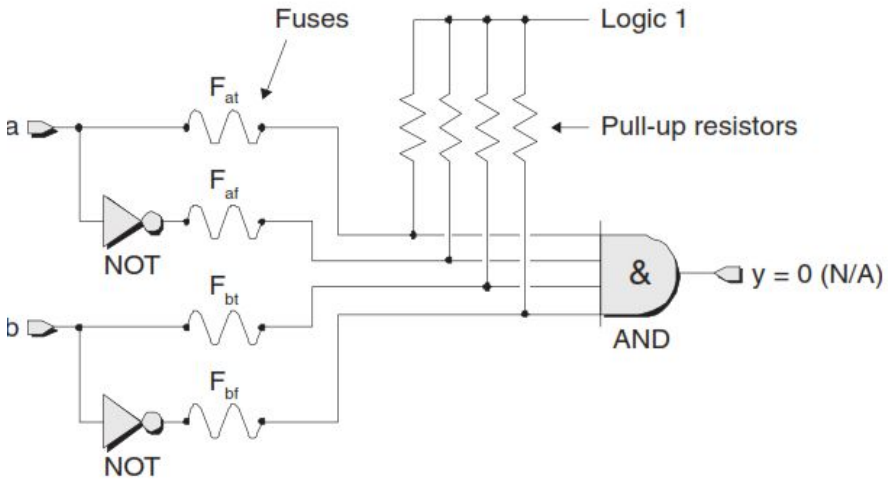
A simple programmable function

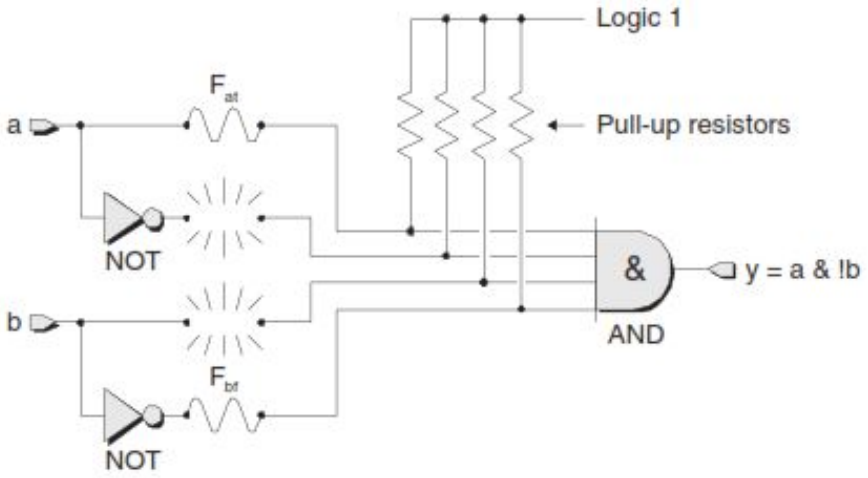


Technology of program logic devices

Fusible link technologies



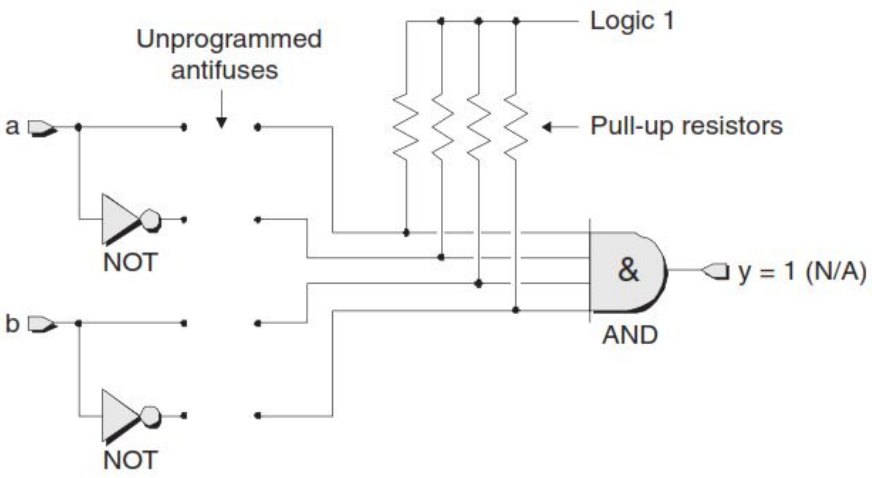
Unprogrammed fusible links



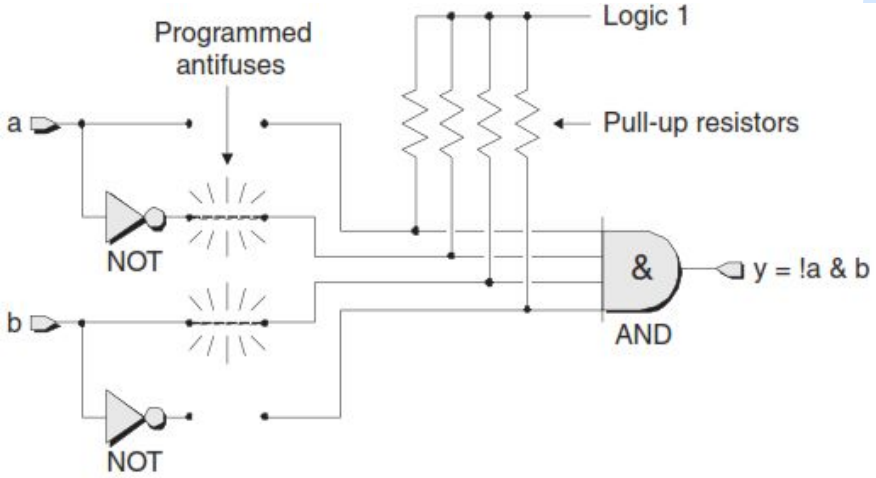
Programmed fusible links

Technology of program logic devices

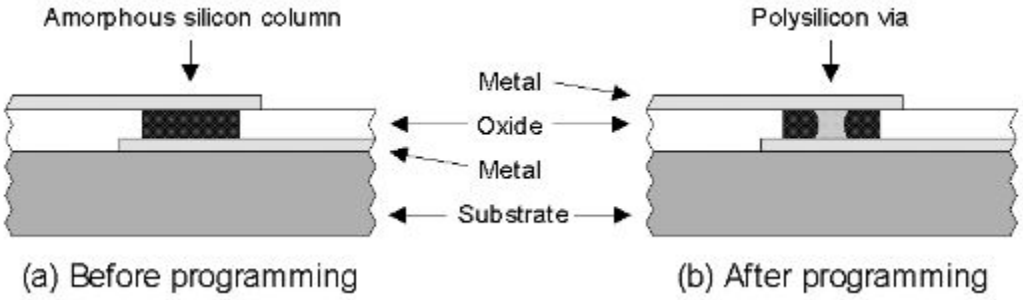
Antifuse technologies



Unprogrammed antifuse links



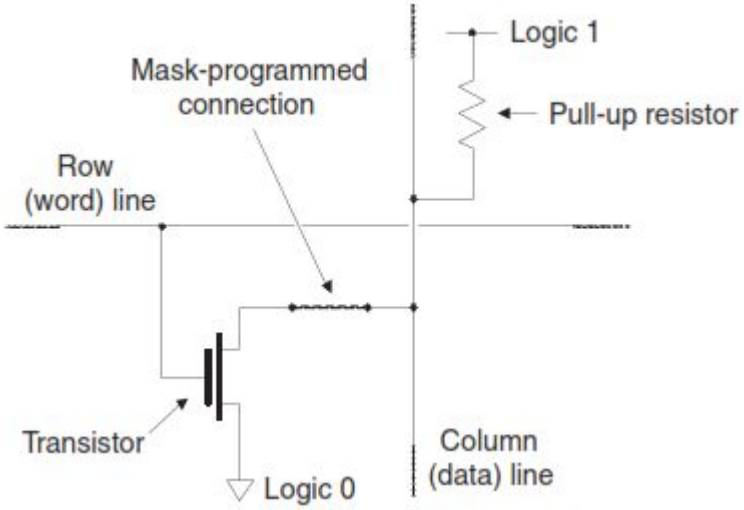
Programmed antifuse links



The act of programming particular element effectively grows a link by converting the insulating amorphous silicon into conducting polysilicon

Physical principles of logic block configuration

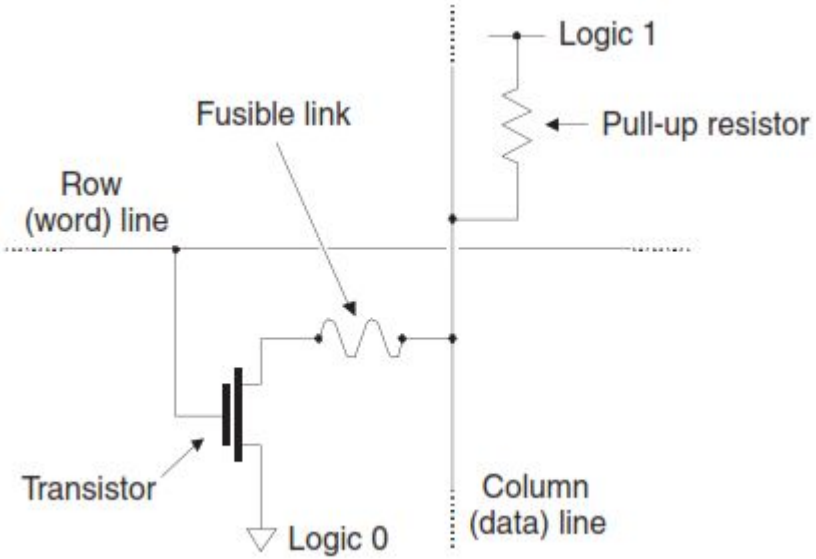
- Mask-programmed devices



A transistor-based mask-programmed ROM cell

- creating is a very expensive
- little used in a development environment in which often need to modify contents

- Programmable read-only memory PROMs

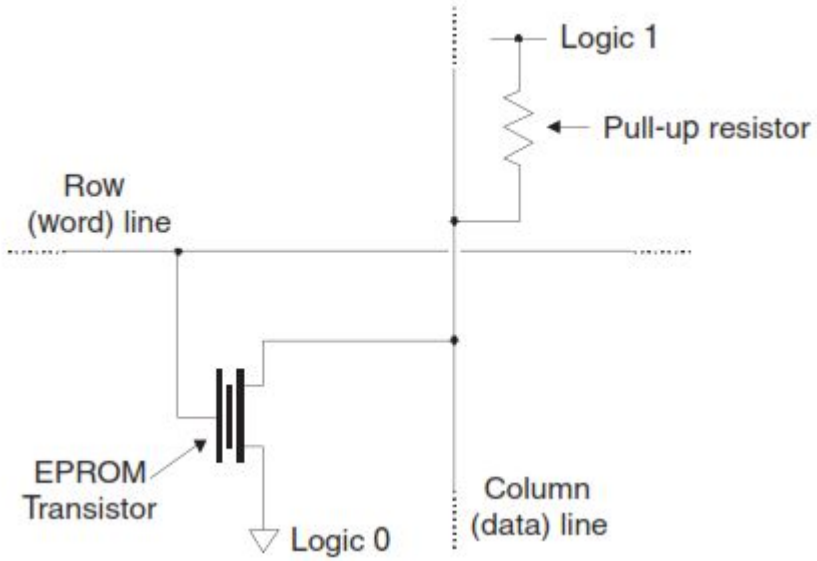


A transistor-based PROM cell

- intended for use as memories to store computer programs
- could be used to fix bugs or test new implementations

Physical principles of logic block configuration

- EPROM-based technologies

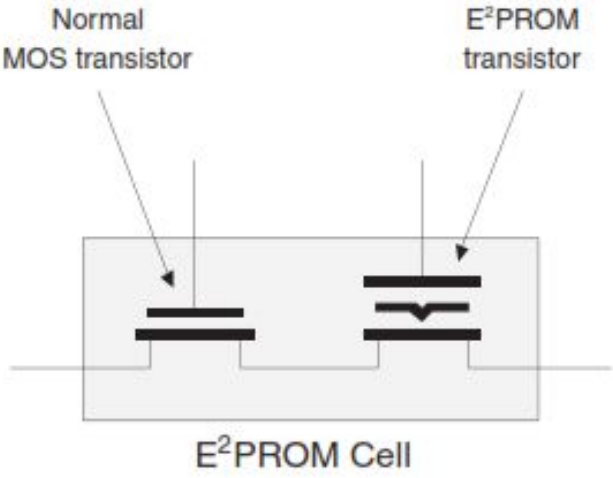


An EPROM transistor-based memory cell

•expensive packages with quartz windows and the time takes to erase

•use as a programmable memories

- EEPROM-based technologies



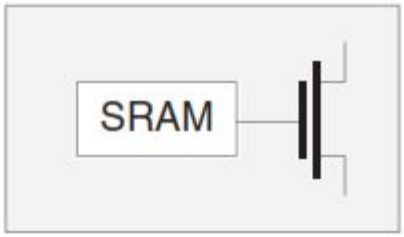
An EEPROM-cell

•EEPROM transistor contains a floating gate, but the insulating oxide layers surrounding this gate are very much thinner

•the second transistor can be used to erase the cell electrically

Physical principles of logic block configuration

- SRAM-based technologies



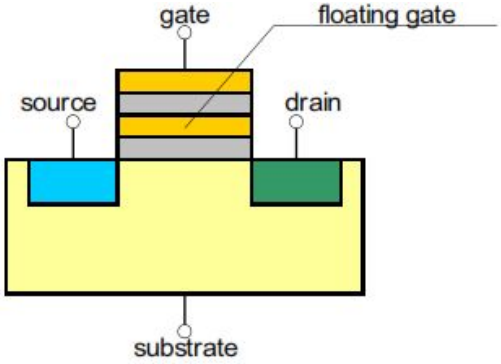
An SRAM-cell programmable cell

•fast re-programmabalaty

•standard IC fabrication technologies is used

•requires large area

- Flash-based technologies



A floating-gate transistor used in flash memory

•electrically erased

•less power

•tolerant to radiation effect

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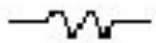
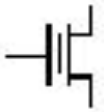
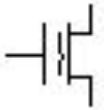
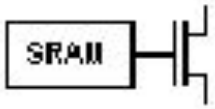
Summary of programming technologies

Technology	Symbol	Predominantly associated with ...
Fusible-link		SPLDs
Antifuse		FPGAs
EPROM		SPLDs and CPLDs
E^2PROM/ FLASH		SPLDs and CPLDs (some FPGAs)
SRAM		FPGAs (some CPLDs)