CME 2003
Logic Design

Programmable Logic

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INTRODUCTION TO PROGRAMMABLE LOGIC

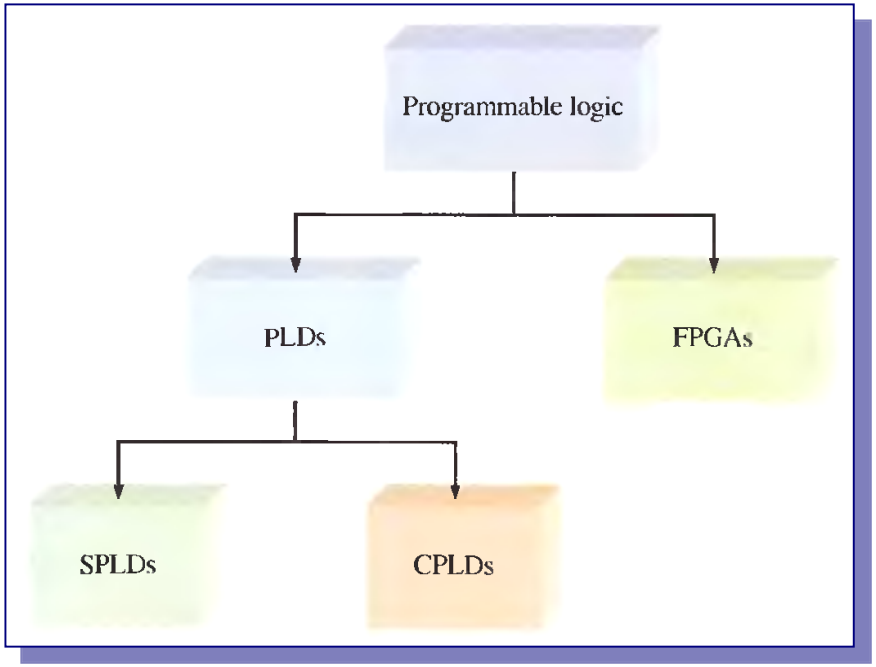
- Programmable logic requires both hardware and software.
- Programmable logic devices can be programmed to perform specified logic functions by the manufacturer or by the user.
- Advantage of programmable logic over fixed-function logic:
  - the devices **use much less board space** for an equivalent amount of logic,
  - designs can be **readily changed** without rewiring or replacing components.
  - a logic design can generally be **implemented faster and with less cost** with programmable logic than with fixed-function ICs.

Types of Programmable Logic Devices

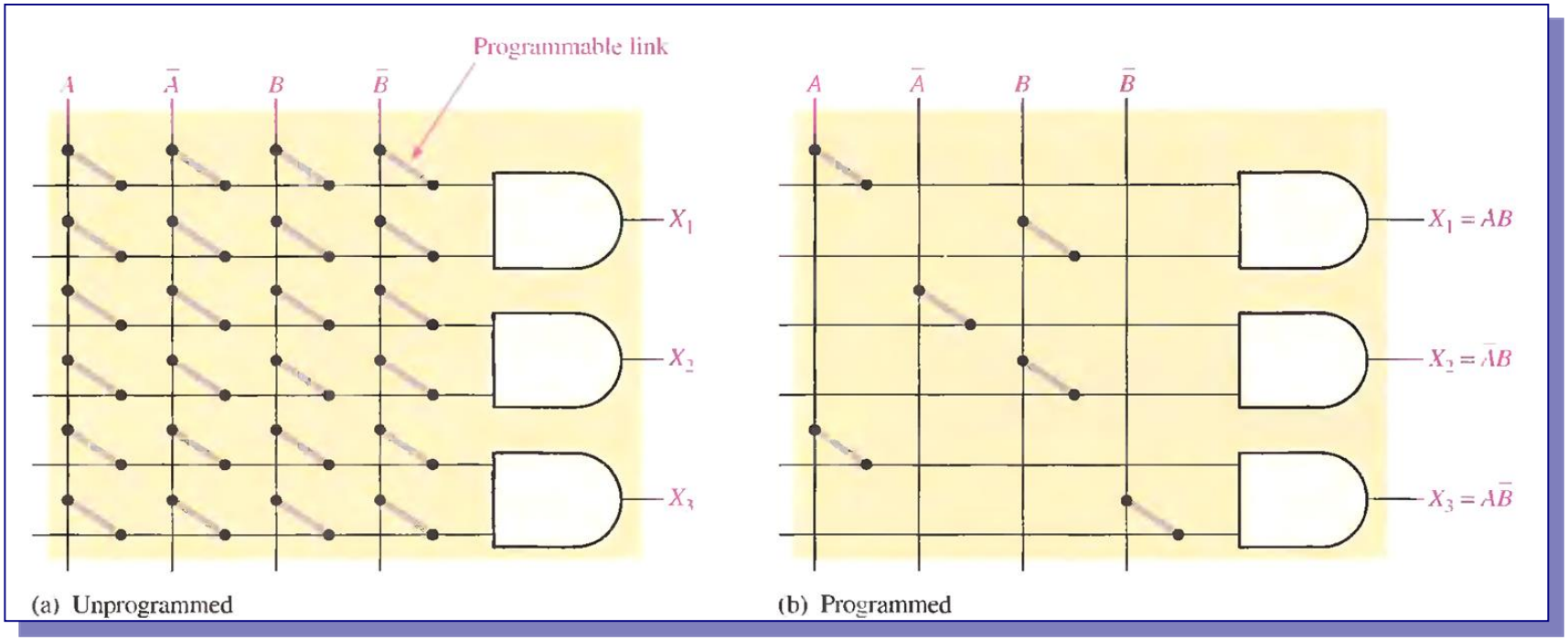
PLD :Programmable Logic Device

- SPLDs (simple PLDs)
  - GAL
  - PAL
- CPLDs (complex PLDs).

FPGA : Field Programmable Gate Array

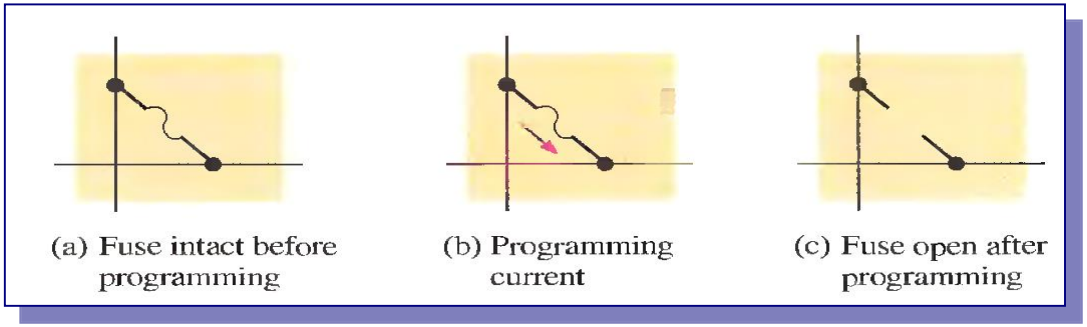


Basic Concept of a Programmable AND Array



Programmable Link Process Technologies

- Fuse Technology

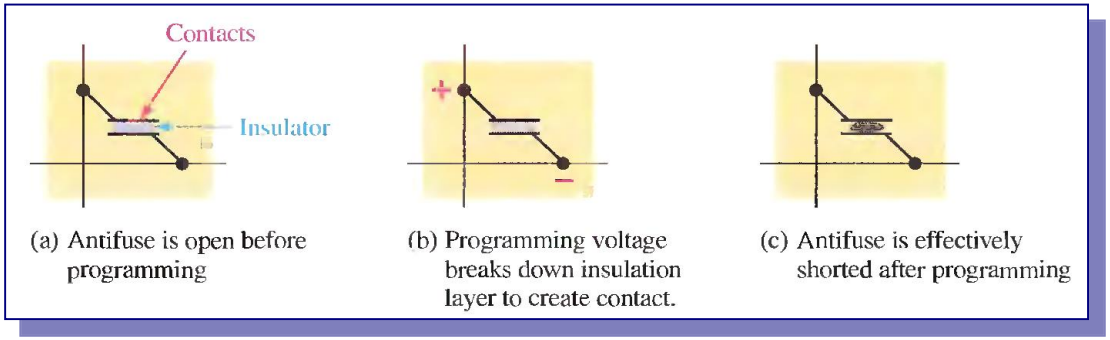


(a) Fuse intact before programming

(b) Programming current

(c) Fuse open after programming

- Antifuse Technology



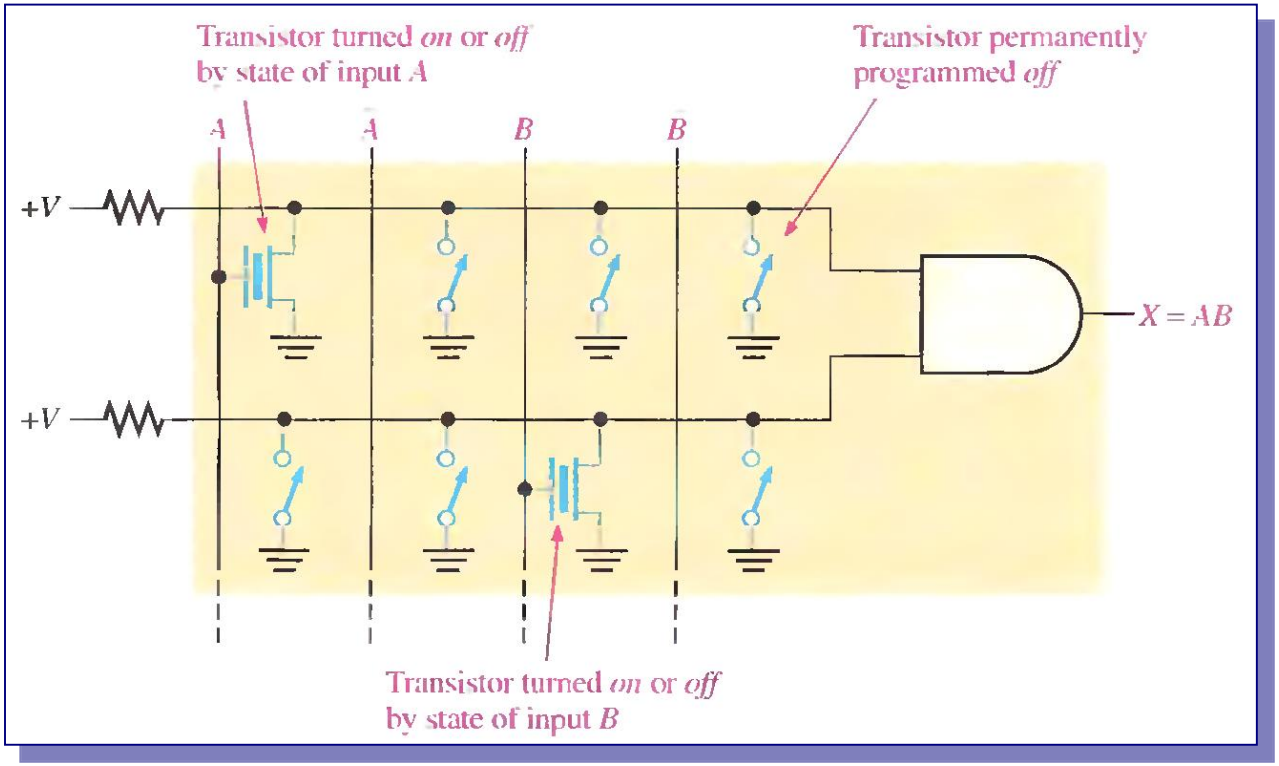
(a) Antifuse is open before programming

(b) Programming voltage breaks down insulation layer to create contact.

(c) Antifuse is effectively shorted after programming

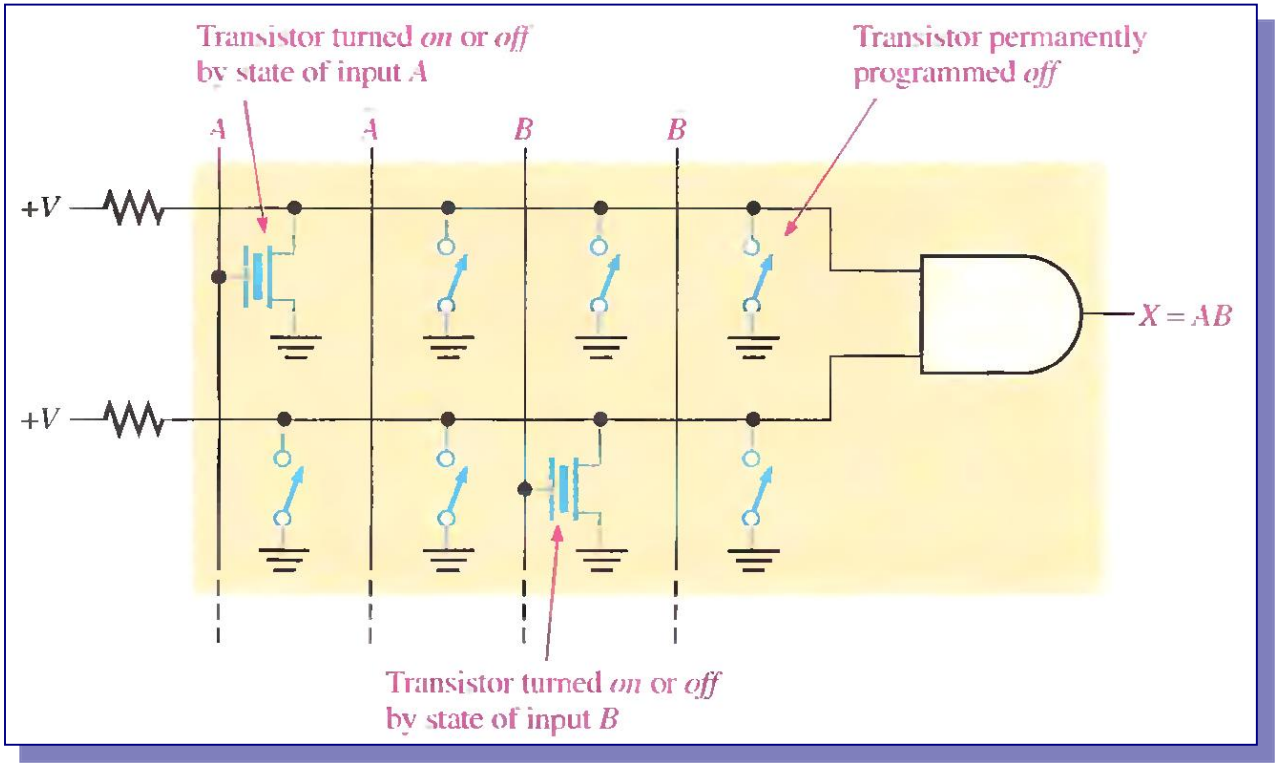
… Programmable Link Process Technologies

- EPROM Technology



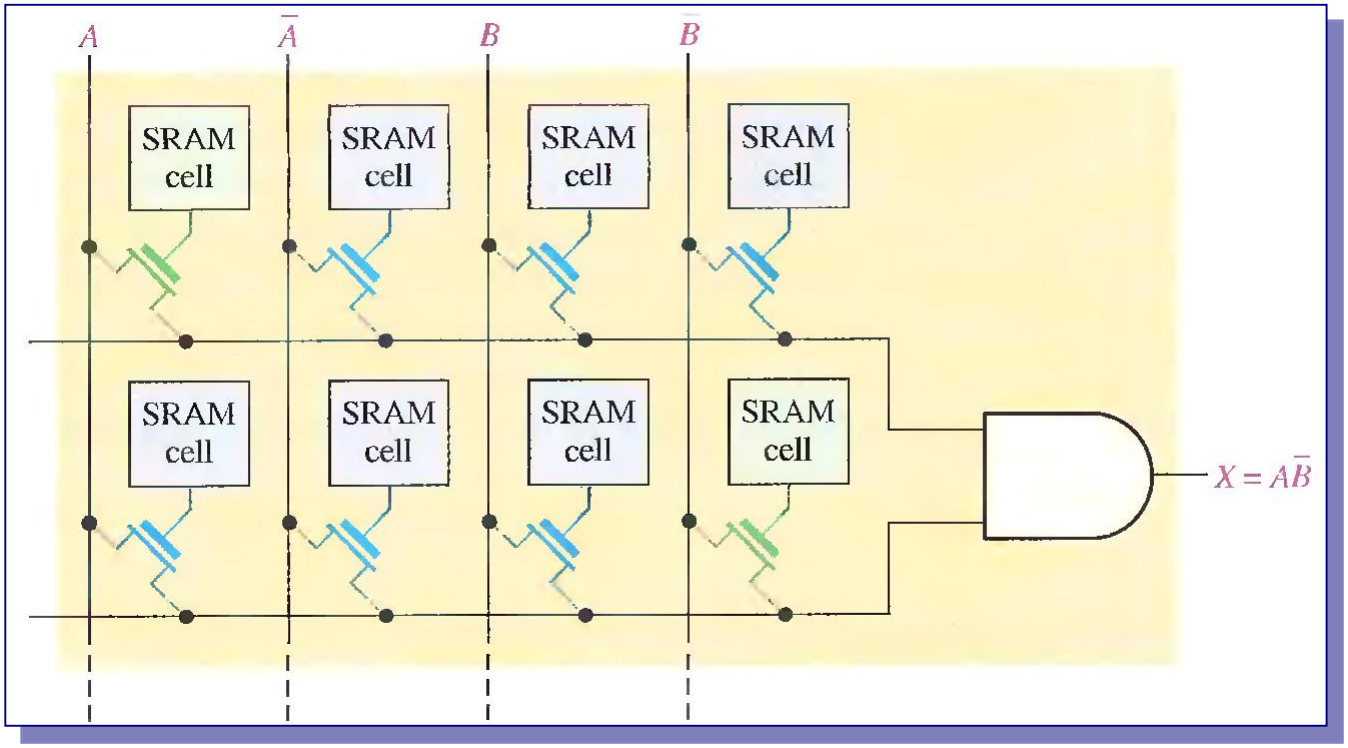
… Programmable Link Process Technologies

- EEPROM Technology



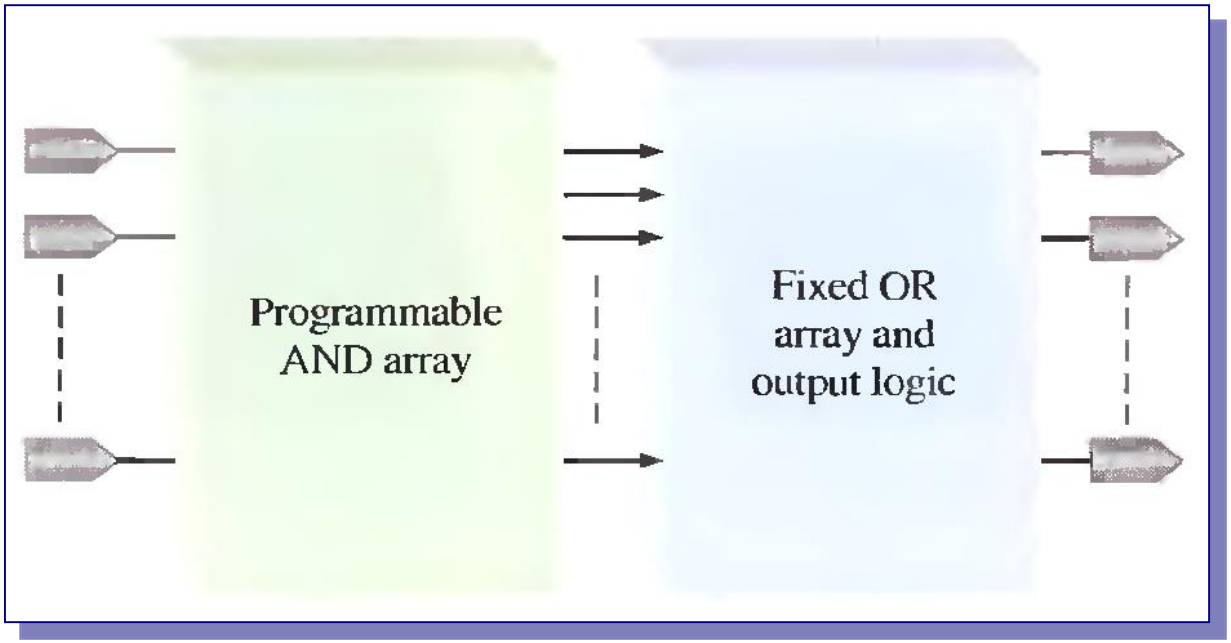
… Programmable Link Process Technologies

- SRAM Technology



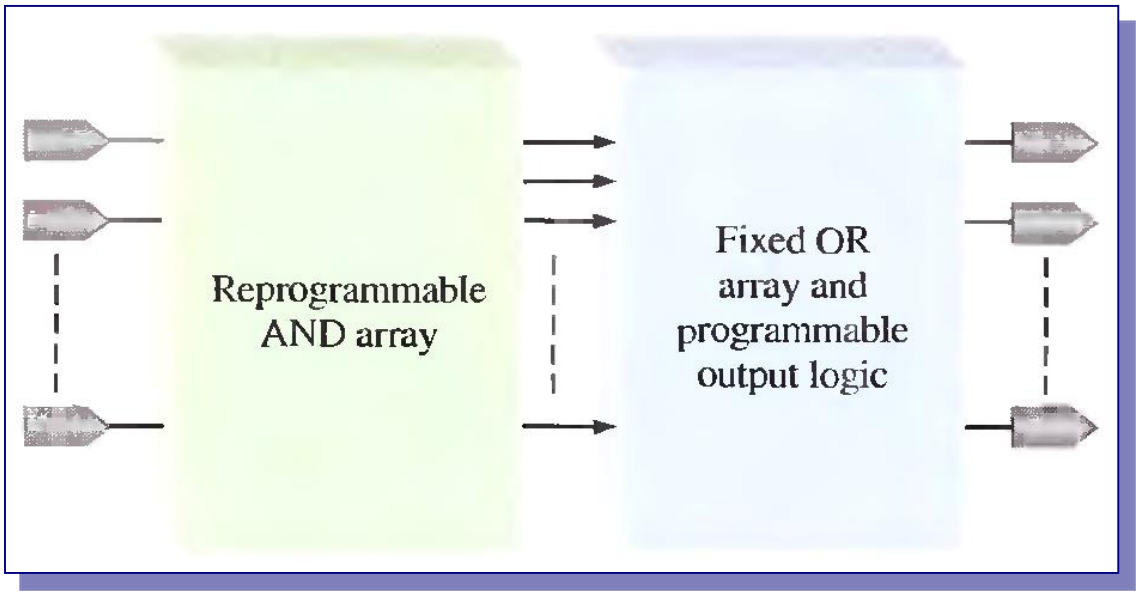
PAL : Programmable Array Logic

- programmed one time.
- consists of a programmable array of AND gates and a fixed array of OR gates,



GAL : Generic Array Logic

- reprogrammed many times
- consists of a reprogrammable array of AND gates and a fixed array of OR gates with programmable ouputs.

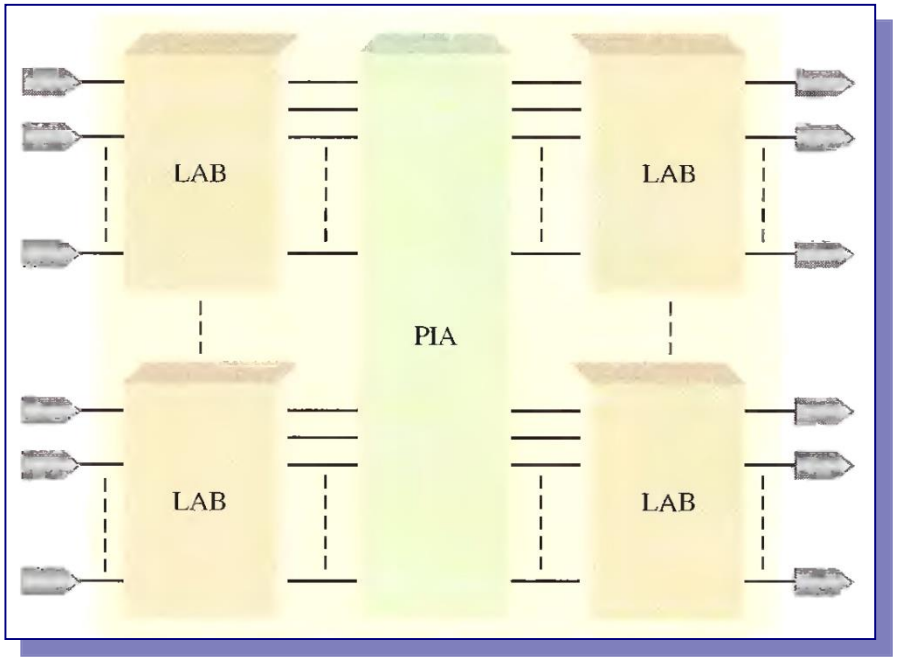


Complex Programmable Logic Device (CPLD)

- more than one SPLD on a single chip and the CPLD
- many fixed-function

LAB: *Logic Array Blocks*

PIA: *Programmable Interconnection Array*

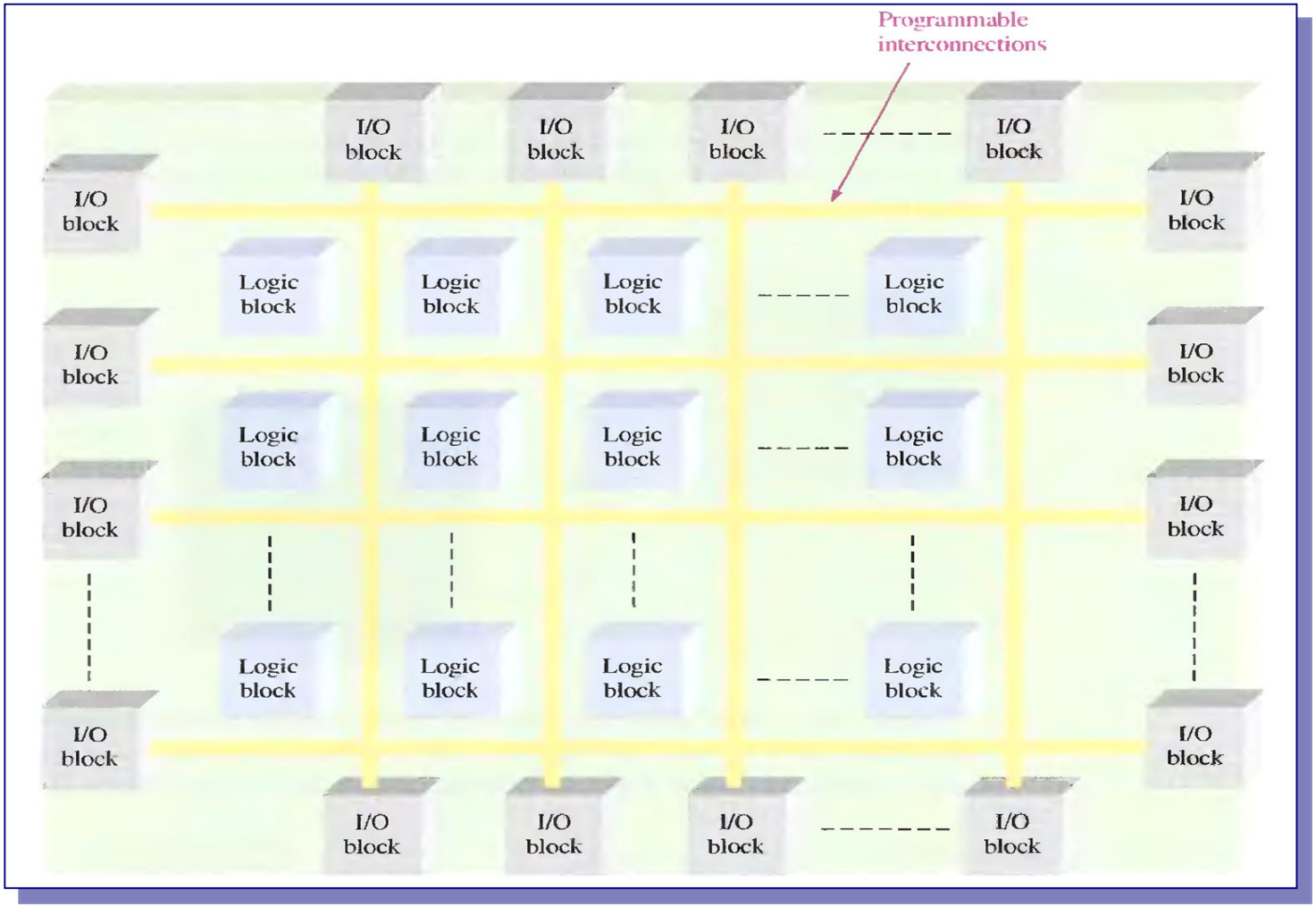


General block diagram of a CPLD

Field Programmable Gate Array (FPGA)

- higher density than a CPLD.
- basic elements:
  - Logic blocks,
  - the programmable interconnections,
  - the input/output (I/O) blocks.
- The logic blocks in an FPGA are not as complex as the logic array blocks (LABs)

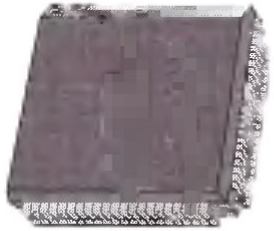
Basic Structure of FPGA



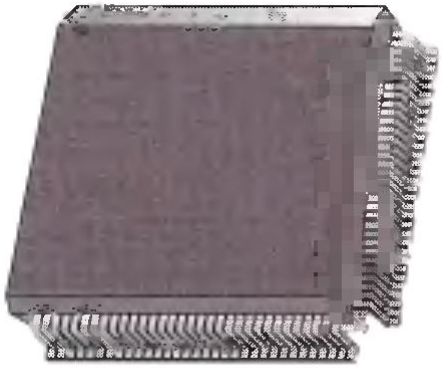
…FPGA

- Logic Block (size)
  - fine-grained : simple logic blocks
  - coarse-grained : larger and more complex logic blocks,
- I/O blocks (selectable)
  - input,
  - output,
  - Bidirectional
- distributed programmable interconnection matrix provides for interconnection of the logic blocks and connection to inputs and outputs.
- Large FPGAs can have tens of thousands of logic blocks in addition to memory and other resources.

Typical SPLD package.

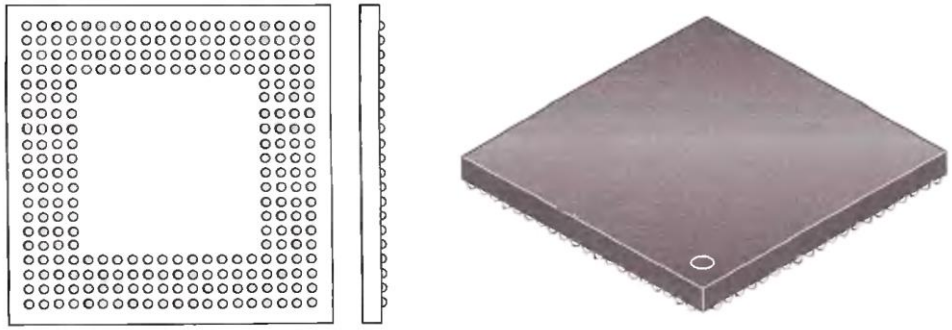


(a) 84-pin PLCC package



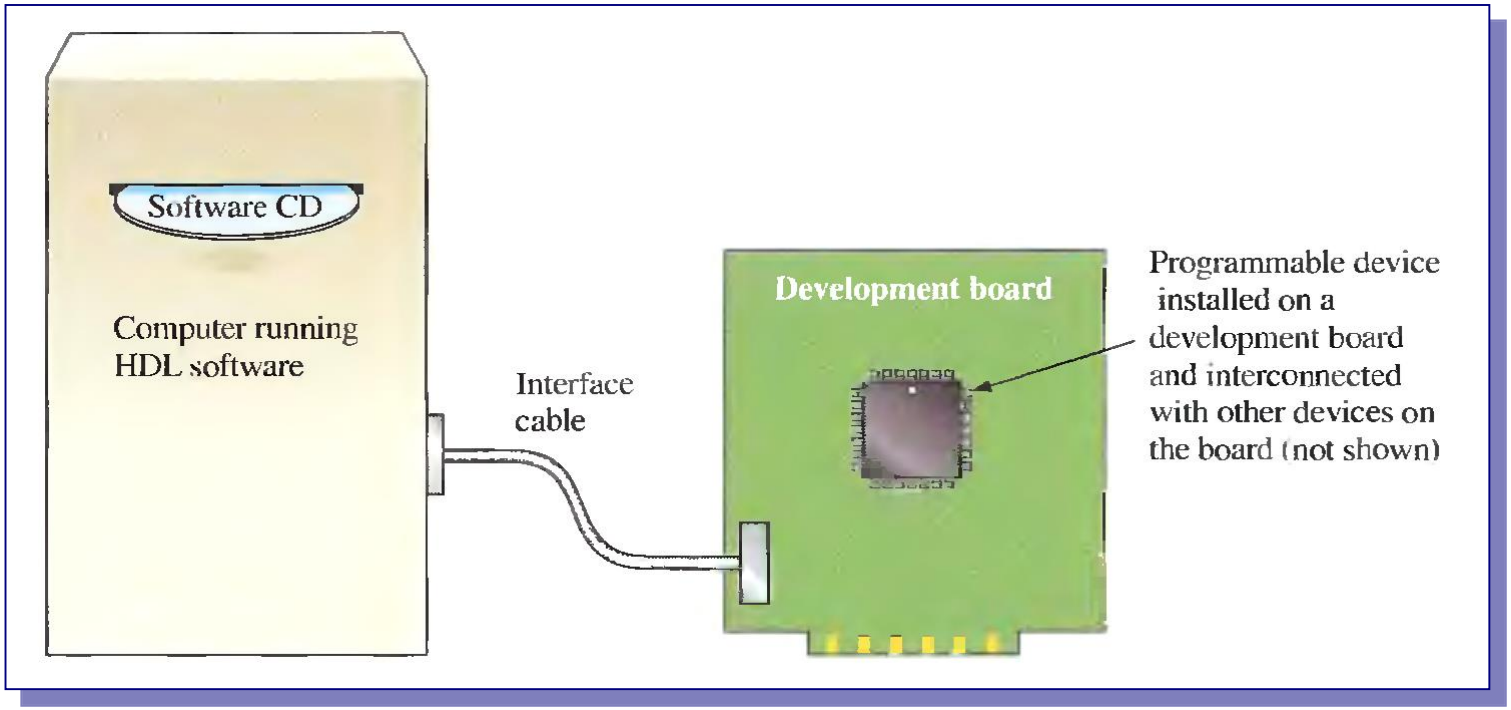
(b) 128-pin PQFP package

Typical CPLD package.

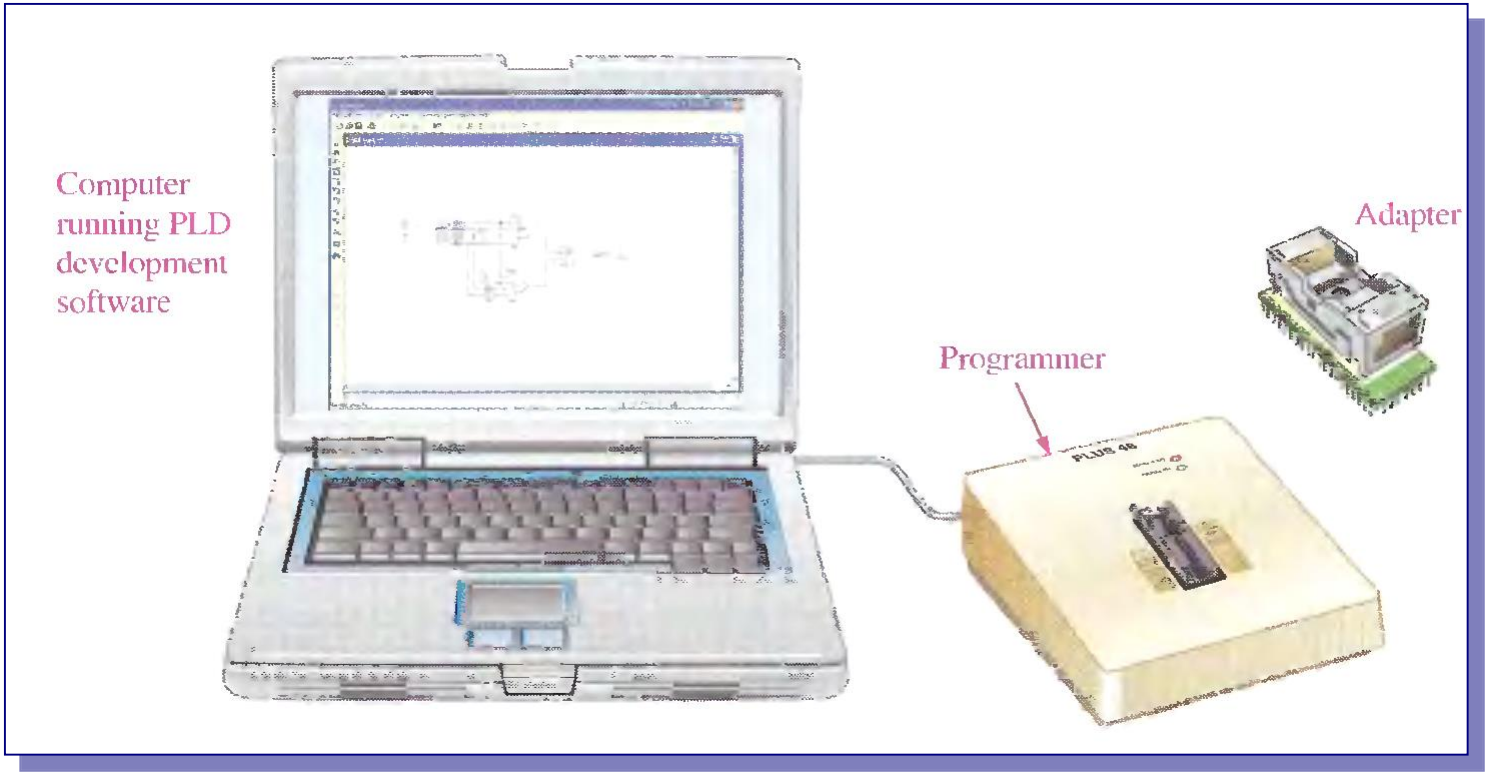


A typical FPGA ball-grid array package

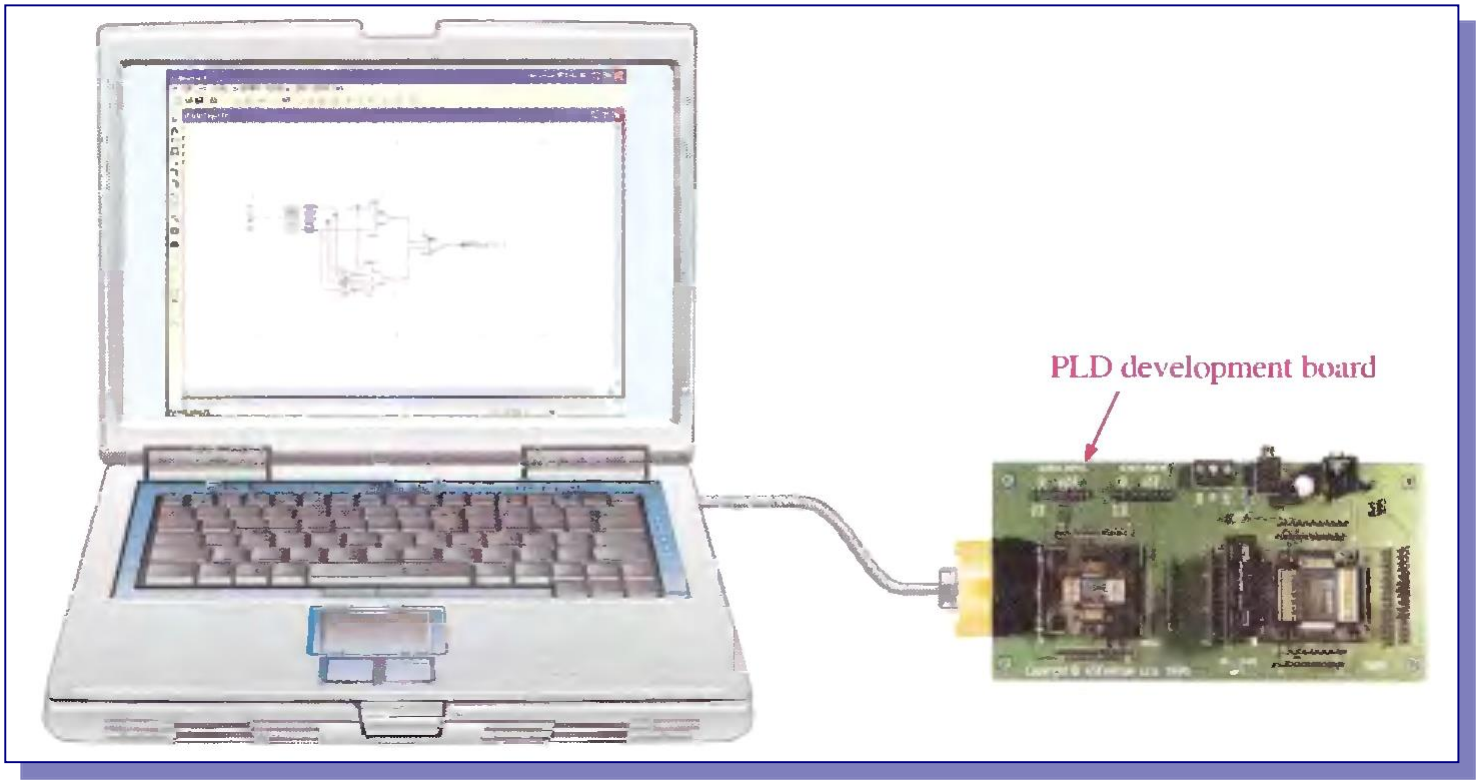
Basic Configuration for Programming a PLD or FPGA.



… Basic Configuration for Programming



… Basic Configuration for Programming



Basic programmable logic design flow block diagram.