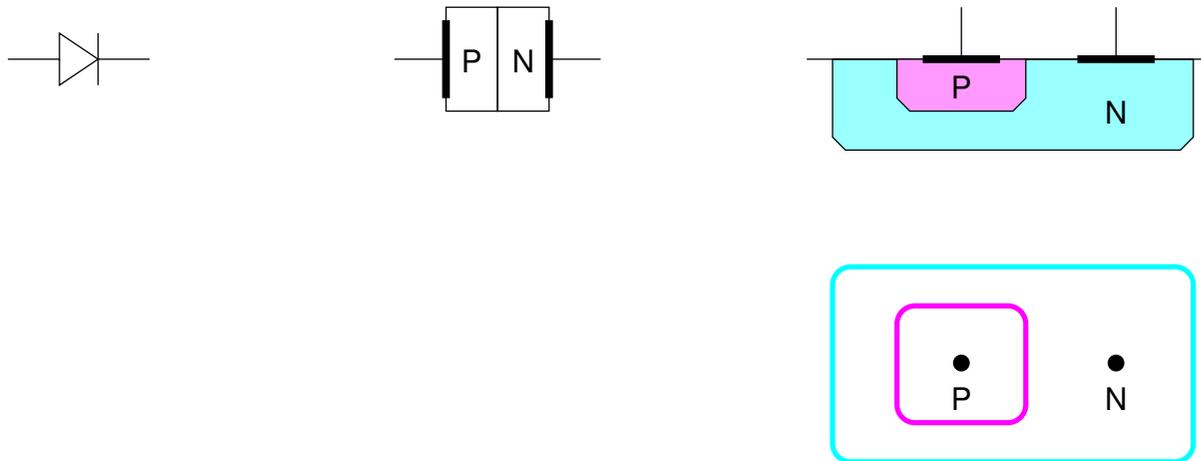


Components for Digital IC Design

Diodes and Bipolar Transistors

Diode

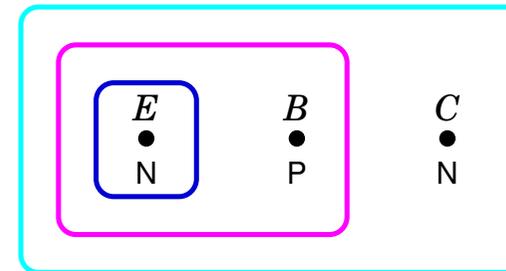
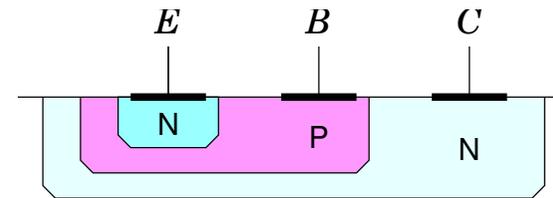
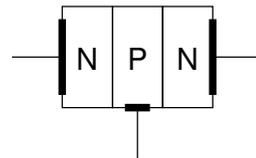
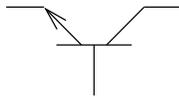


- Ideal structure - 1D
- Real structure - 3D
- Depth controlled implants.

Components for Digital IC Design

Diodes and Bipolar Transistors

NPN Transistor

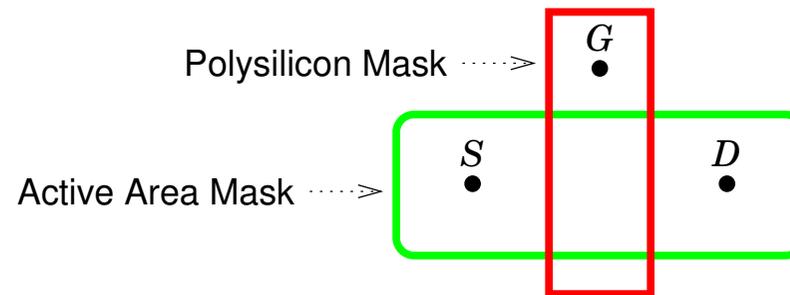
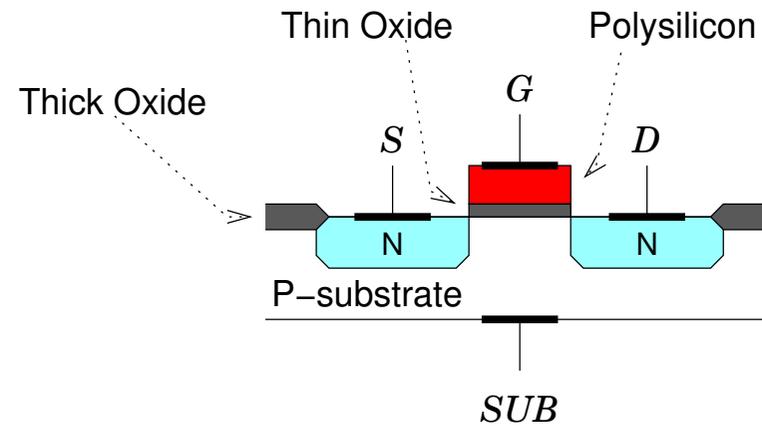
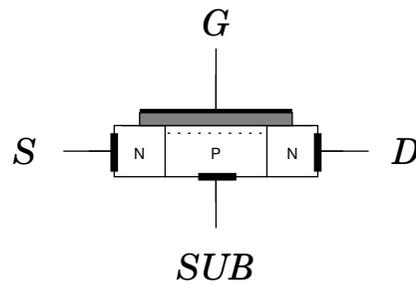
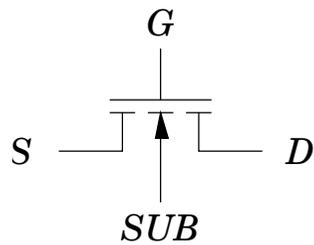


- Two n-type implants.

Components for Digital IC Design

MOS Transistors

Simple NMOS Transistor



Components for Digital IC Design

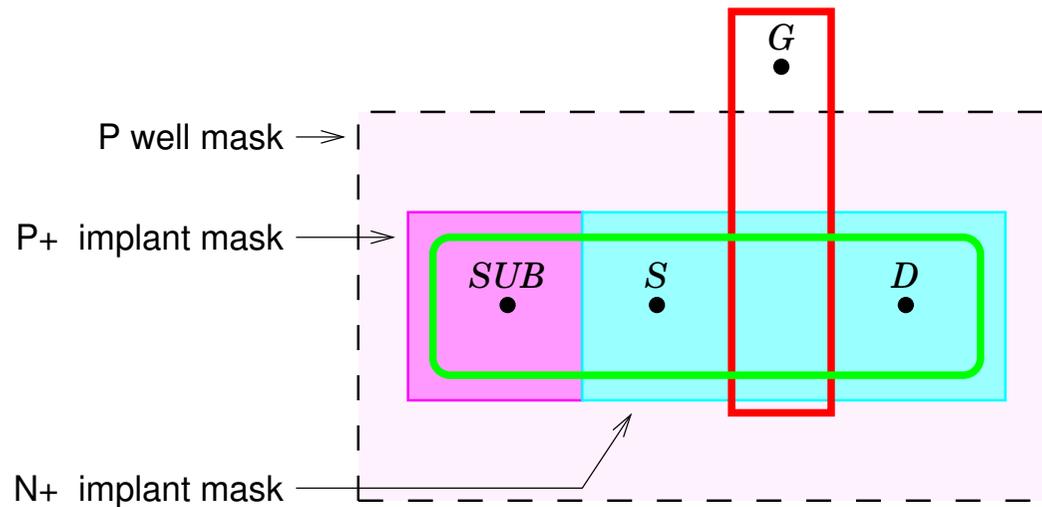
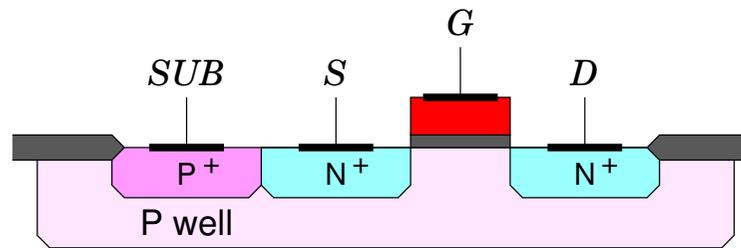
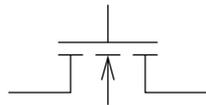
Simple NMOS Transistor

- Active Area mask defines extent of *Thick Oxide*.
- Polysilicon mask also controls extent of *Thin Oxide* (alias *Gate Oxide*).
- N-type implant has no extra mask.
 - It is blocked by thick oxide and by polysilicon.
 - The implant is *Self Aligned*.
- Substrate connection is to bottom of wafer.
 - All substrates to ground.
- Gate connection not above transistor area.
 - Design Rule.

Components for Digital IC Design

MOS Transistors

NMOS Transistor



Components for Digital IC Design

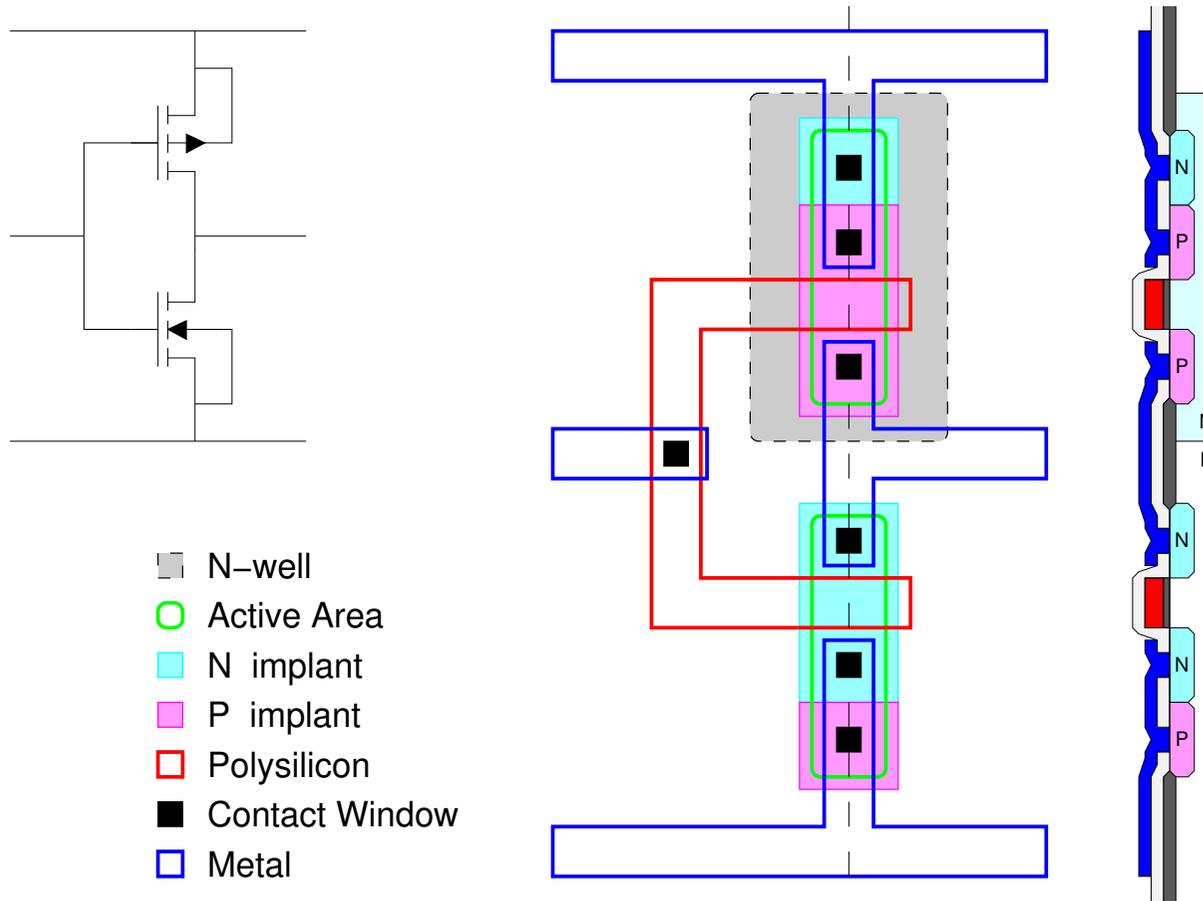
NMOS Transistor

Where it is not suitable for substrate connections to be shared, a more complex process is used.

- Five masks must be used to define the transistor:
 - P Well
 - Active Area
 - Polysilicon
 - N+ implant
 - P+ implant
- P Well, for isolation.
- Top *substrate* connection.
- P+/N+ implants produce good *ohmic* contacts.

CMOS Process

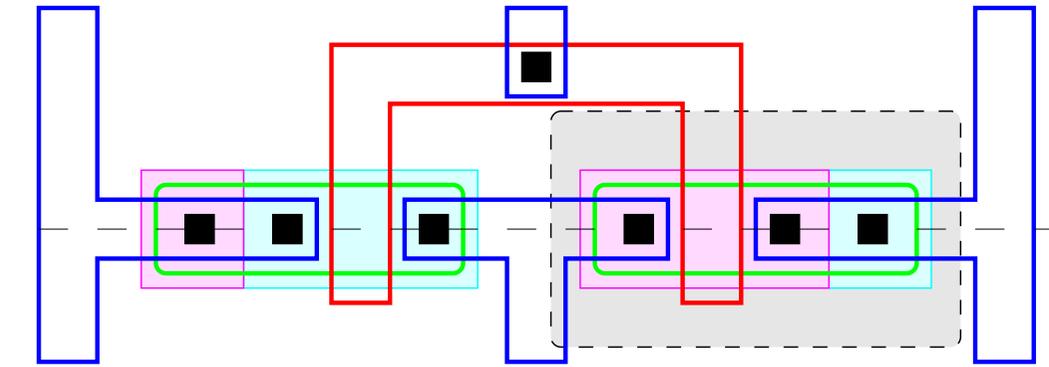
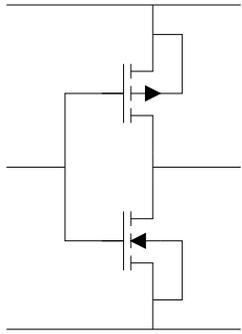
CMOS Inverter



CMOS Process

CMOS Inverter

- The process described here is an *N Well process* since it has only an N Well. P Well and Twin Tub processes also exist.
- Note that the P-N junction between chip substrate and N Well will remain reverse biased.
Thus the transistors remain isolated.
- N implant defines NMOS source/drain and PMOS substrate contact.
- P implant defines PMOS source/drain and NMOS substrate contact.



-  N-well
-  Active Area
defines Thick Oxide
-  Polysilicon
defines Thin Oxide
-  N implant
aligned to AA and Poly
-  P implant
aligned to AA and Poly
-  Contact Window
-  Metal

