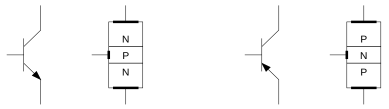
Overview of Technologies

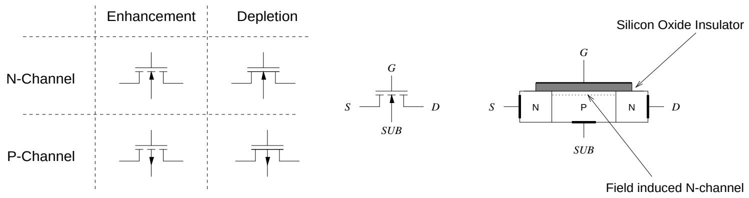
Components for Logic

Diode

Bipolar Transistors

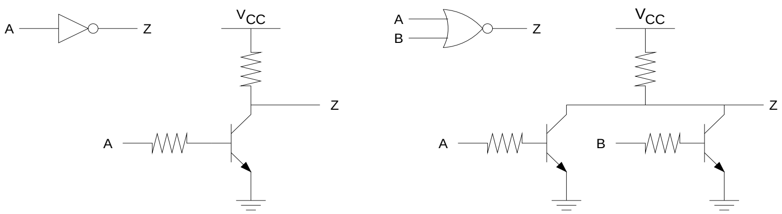


MOS Transistors



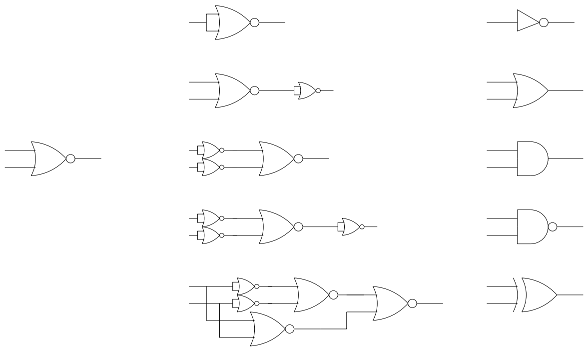
Overview of Technologies

RTL Inverter and NOR gate



Overview of Technologies

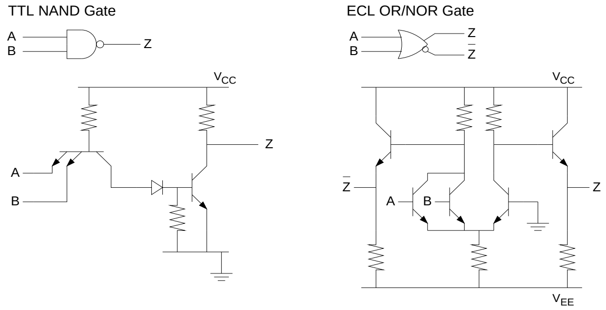
All functions can be realized with a single NOR base gate.[1]



[1]NAND gates could be used instead.

Overview of Technologies

Other Bipolar Technologies

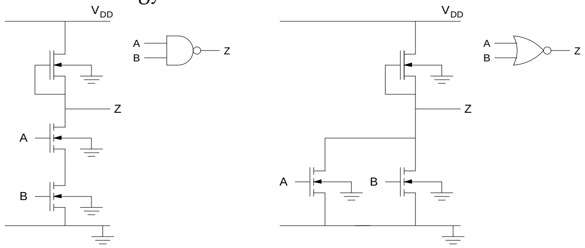


- **TTL** gives faster switching than RTL at the expense of greater complexity[2]. The characteristic multi-emitter transistor reduces the overall component count.
- **ECL** is a very high speed, high power, non-saturating technology.

[2]Most TTL families are more complex than the basic version shown here

Overview of Technologies

NMOS - a VLSI technology.

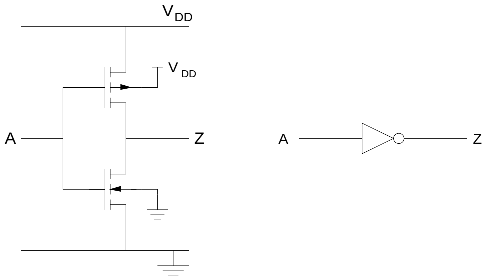


- Circuit function determined by series/parallel combination of devices.
- Depletion transistor acts as non-linear load resistor.
  Resistance increases as the enhancement device turns on, thus reducing power consumption.
- The low output voltage is determined by the size ratio of the devices.

Overview of Technologies

CMOS logic

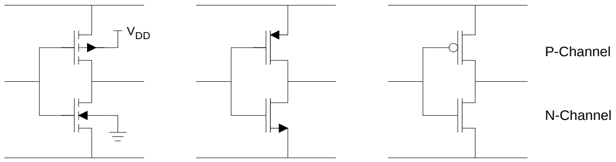
CMOS - *state of the art* VLSI.



- An active PMOS device complements the NMOS device giving:
  - rail to rail output swing.
  - negligible static power consumption.

Digital CMOS Circuits

Alternative representations for CMOS transistors

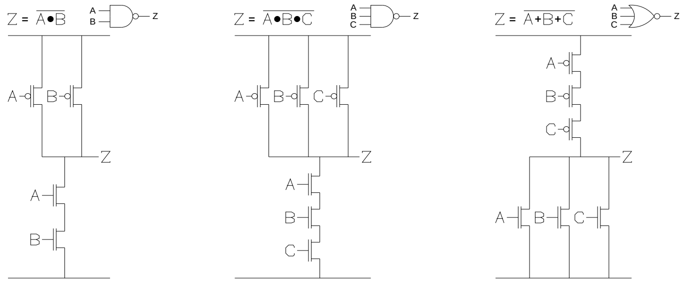


Various shorthands are used for simplifying CMOS circuit diagrams.

- In general substrate connections are not drawn where they connect to Vdd (PMOS) and Gnd (NMOS).
- All CMOS devices are enhancement mode.
- Transistors act as simple digitally controlled switches.

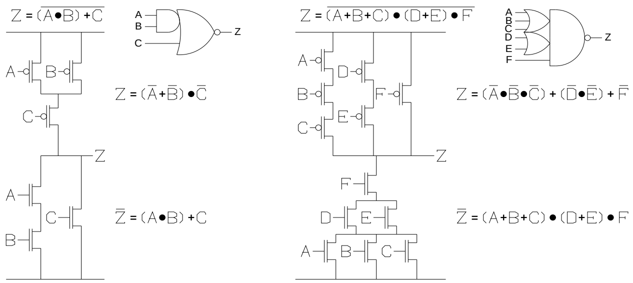
Digital CMOS Circuits

Static CMOS complementary gates



- For any set of inputs there will exist either a path to Vdd or a path to Gnd.

Compound Gates

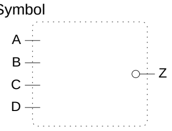


- All compound gates are inverting.
- Realisable functions are arbitrary AND/OR expressions with inverted output.

Compound Gate Example

$Z = \overline{(A \bullet B) + (C \bullet D)}$

Symbol



Pull Up Network

$Z = f(\bar{A},\bar{B},\bar{C},\bar{D})$

$Z =$ ....

Pull Down Network

$\bar{Z} = f(A,B,C,D)$

$\bar{Z} = (A \bullet B) + (C \bullet D)$