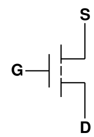
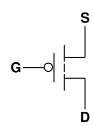
CMOS Summary
Prepared by Robert Dick

1 NMOS Transistors



- No current flows between gate and source or gate and drain
- If $V_{GS} > V_T$, they're on (closed)
  - Current may flow between drain and source
- If $V_{GS} < V_T$, they're off (open)
  - No current flows between drain and source
- They're good at transmitting 0s
- They're bad at transmitting 1s

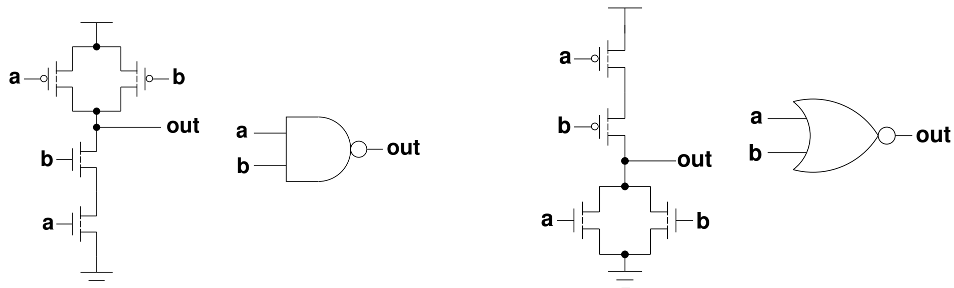
2 PMOS transistors



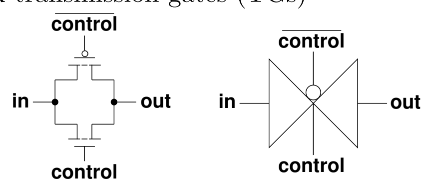
- No current flows between gate and source or gate and drain
- If $V_{GS} < -V_T$, they're on (closed)
  - Current may flow between drain and source
- If $V_{GS} > -V_T$, they're off (open)
  - No current flows between drain and source
- They're good at transmitting 1s
- They're bad at transmitting 0s

3 Basic CMOS Gates

- Draw PMOS transistors on top and NMOS transistors on bottom
- You can use them together to build logic gates, e.g., NANDs and NORs



- You can use them together to build transmission gates (TGs)



These gates are composed of an NMOS and PMOS transistor in parallel. Putting a high value on the control line will close both NMOS and PMOS transistors, connecting the input to the output. In this case, the TG acts like a wire connecting *in* and *out*. Putting a low value on the control line opens both NMOS and PMOS transistors. In this case, the output is not connected to anything. It is *floating*, i.e., the voltage is undefined. In practice, the voltage will frequently be somewhere between V_{DD} and V_{SS}. If the output is connected to the input of a logic gate, it might be $(V_{DD} + V_{SS})/2$, which would result in NMOS and PMOS transistors in the logic gate being on at the same time. That could cause a short-circuit. Why are both an NMOS and PMOS transistor needed? Because an NMOS allows only a low value to pass from input to output and the PMOS allows only a high value to pass from input to output. Together, they cover both cases, making the TG act like a wire when *control* is high.