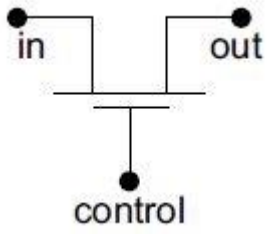

Figure 1 An NMOS switch with terminals.

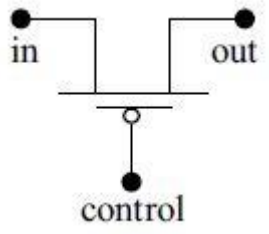

Figure 2 A PMOS switch with terminals

In the table the symbol "**L**" stands for 0 or **z** state. The symbol **H** stands for the 1 or **z** state.

Table 1 Output values of an nmos switch for different values of signal and control inputs

(Data) input	Control (input) 0	1	X	z
0	Z	0	L	L
1	Z	1	H	H
X	Z	X	X	X
z	z	z	z	z

Table 2 Output values of a pmos switch for different values of signal and control inputs

(Data) input	Control (input) 0	1	X	z
0	Z	0	L	L
1	Z	1	H	H
X	Z	X	X	X
z	z	z	z	z

- **nmos** and **pmos** represent switches of low impedance in the on-state.

- **rnmos** and **rpmos** represent the resistive counterparts of these respectively.

- Typical instantiations have the form
  - **rnmos** (output1, input1, control1);
  - **rpmos** (output2, input2, control2);

- With **rnmos** if the control1 input is at 1 (high) state, the switch is ON and functions as a definite resistance. It connects input1 to output1 through a resistance. When control1 is at the 0 (low) state, the switch is OFF and leaves output1 floating. The set of output values for all combinations of input1 and control1 values remain identical to those of the **nmos** switch given in Table 1.

- The **rpmos** switch is ON when control2 is at 0 (low) state. It inserts a definite resistance between the input and the output signals but retains the signal value. The output values for different input values remain identical to those in Table 2 for the **pmos** switch.

pullup and pulldown

- A MOS transistor functions as a resistive element when in the active state
- Realization of resistance in this form takes less silicon area in the IC as compared to a resistance realized directly
- **pullup** and **pulldown** represent such resistive elements
- A typical instantiation here has the form **pullup** (x);
- Here the net x is pulled up to the **supply1** through a resistance
- Similarly, the instantiation **pulldown**(y);
- pulls y down to the **supply0** level through a resistance
- The **pullup** and **pulldown** primitives can be used as loads for switches or to connect the unused input ports to *V*CC or GND, respectively
- They can also form loads of switches in logic circuits
- The default strengths for **pullup** and **pulldown** are **pull1** and **pull0** respectively. One can also specify strength values for the respective nets

For example

- **pullup** (**strong1**) (x)
- specifies a resistive **pullup** of net x to **supply1**

- One can also assign names to the **pullup** and **pulldown** primitives

  - Thus **pullup** (**strong1**) rs(x) represents an instantiation of **pullup** designated rs having strength **strong1**

- Difference between **tri** and **pullup** or **pulldown** is to be understood clearly

- **pullup** is a functional element; it represents a resistive connection to **supply1**

- In contrast **tri1** is a type of net; in the absence of an assignment, it remains connected to **supply1**

- A similar difference exists between **pulldown** and **tri0**