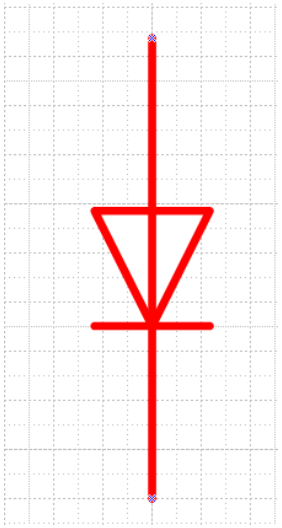
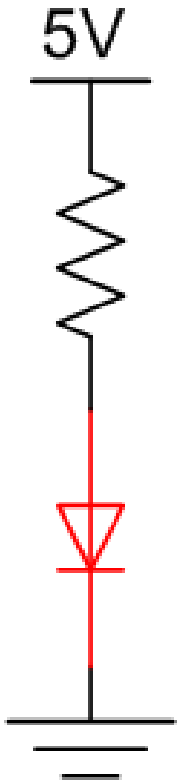
LED



This is the symbol of LED. The commonly used LED for visual indication has forward voltage of roughly 0.7V and current of 1mA to 20mA.

So, how to turn on or switch on the LED?

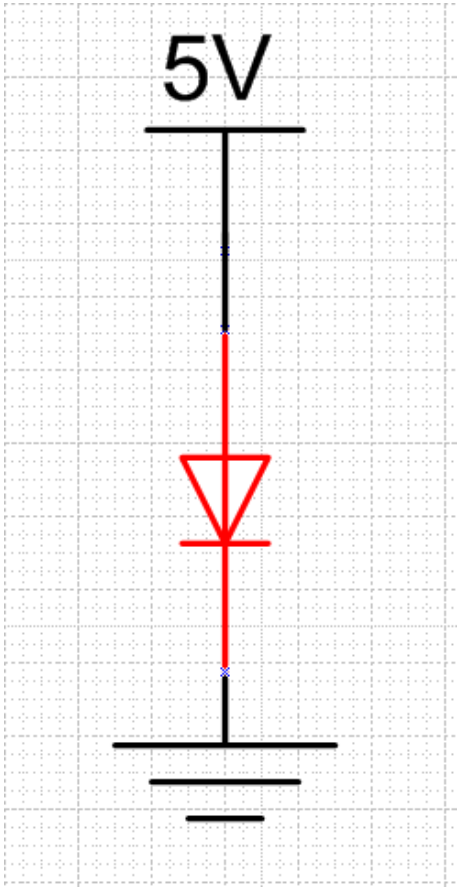
Ballast Resistor



You will see that a ballast resistor is always connected to the LED. Why?

Ask yourself before you move on...

Who is the winner?



If forward voltage of 0.7V corresponds to forward current of 10mA, what is the current for forward voltage of 5V?

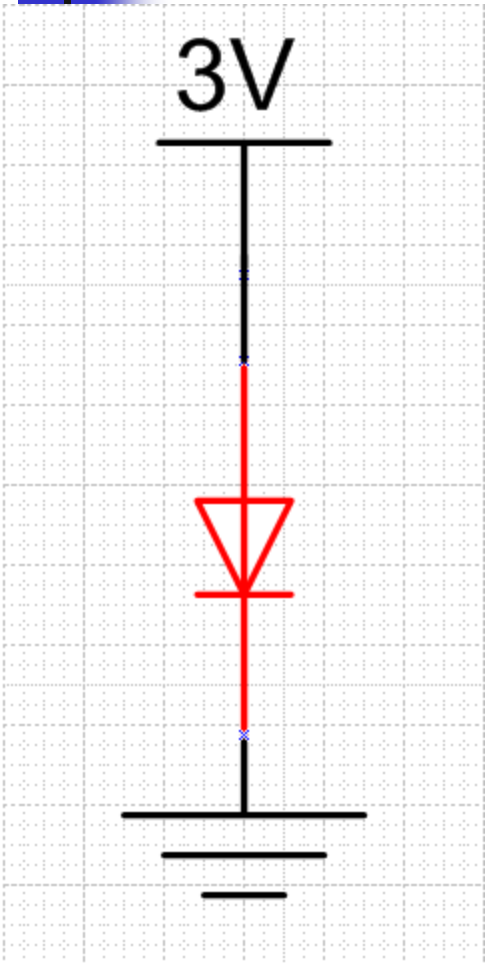
The current will be large.

Your voltage source must be able to provide this large current. Test Bench Power Supply that commonly use in the lab can provide up to a few A of current, so it is ok. In such case, if your LED cannot take the large current, it will burn!

If your voltage source come from a IO port of micro-controller, which can provide only limited amount of current, then that IO port might burn!

That is why ballast R is needed to limit the current drawn by LED.

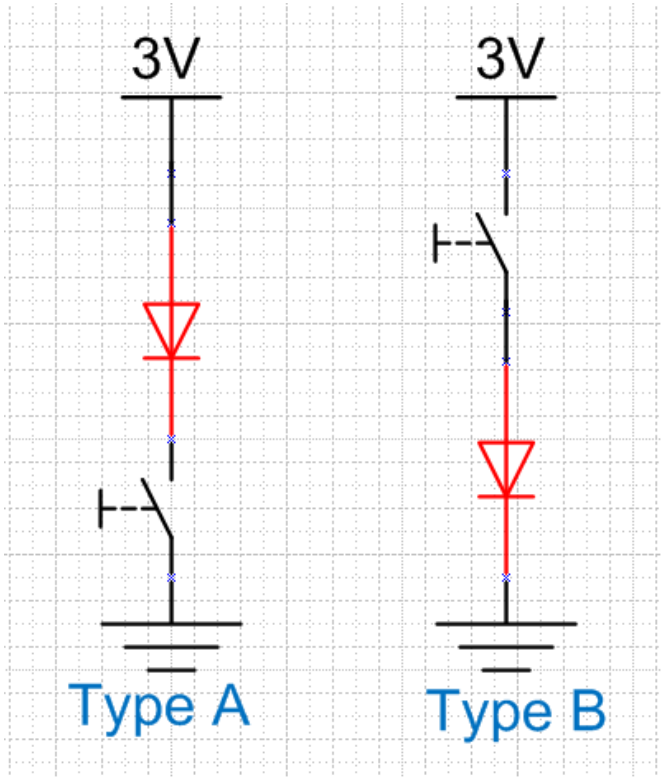
Take calculated risk



To make thing simple, I am going to remove the ballast R and assume 3V come from a output port of micro-controller. Assuming also that logic 0 is 0V and logic 1 is 3V.

Without ballast R, is it safe?

Datasheet is easy to read for the expert?

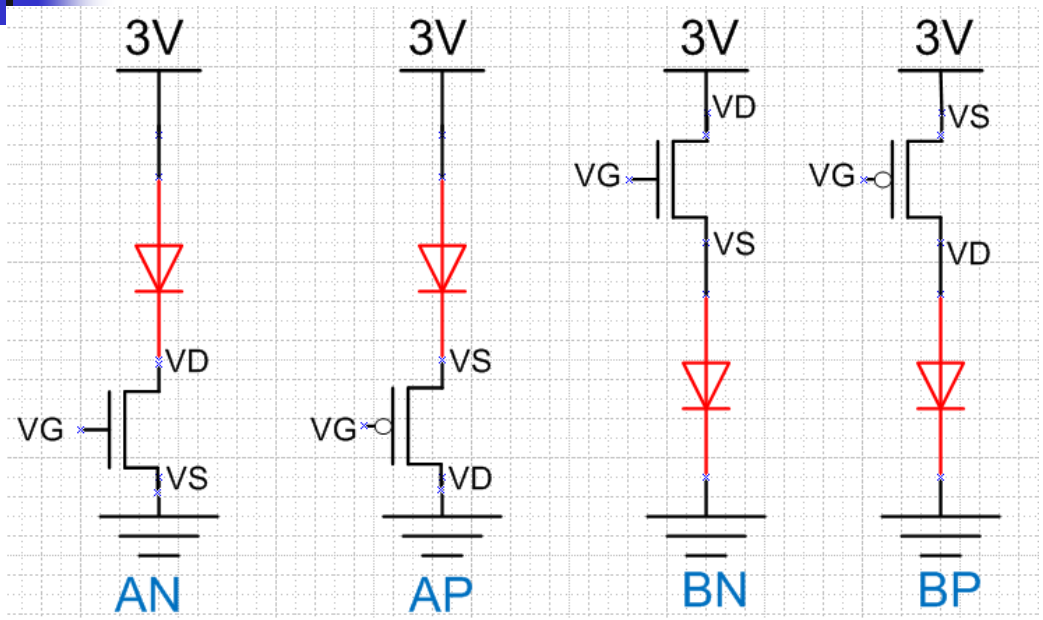


To be sure, you need to check with the datasheet of micro-controller and LED.

I will think it is safe especially if you have spare LEDs and micro-controller boards.

To turn on/off LED, you have 2 ways: Type A and Type B.

Using MOS switch

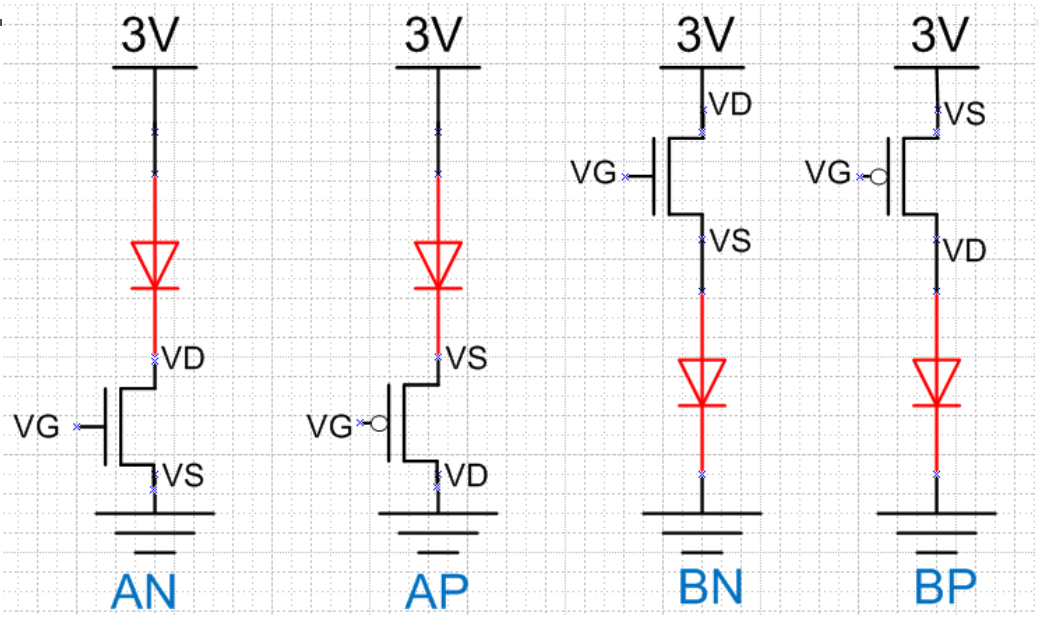


Since we are interested about PMOS and NMOS, there are 4 types now.

Remember in IC, NMOS source terminal is defined as the terminal with lower voltage (as compare to drain terminal). As for PMOS, source terminal is defined as the terminal with higher voltage.

So, how to turn on and off the LED?

Using MOS switch

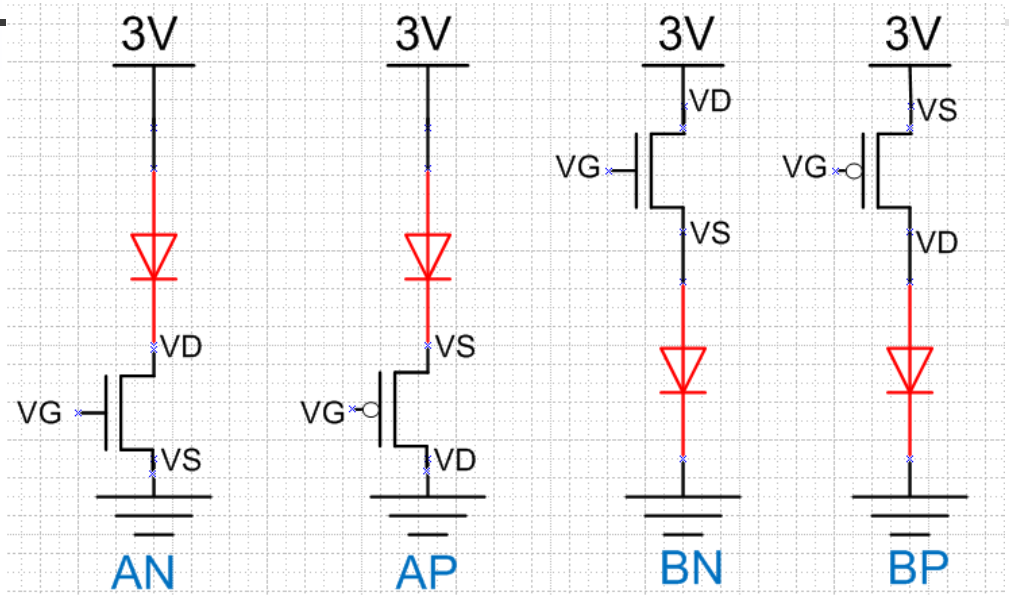


You need to provide logic 0 or 1 to VG. Digital signal at output of micro-controller port is either logic 0 (0V) or 1 (3V) in our discussion here.

The purpose of MOS switch is to transfer logic from one terminal to another terminal.

For type AN and AP, to transfer logic 0 to cathode of LED in order to turn on LED.
For type BN and BP, to transfer logic 1 to anode of LED in order to turn on LED.

NMOS transfer logic 0 perfectly



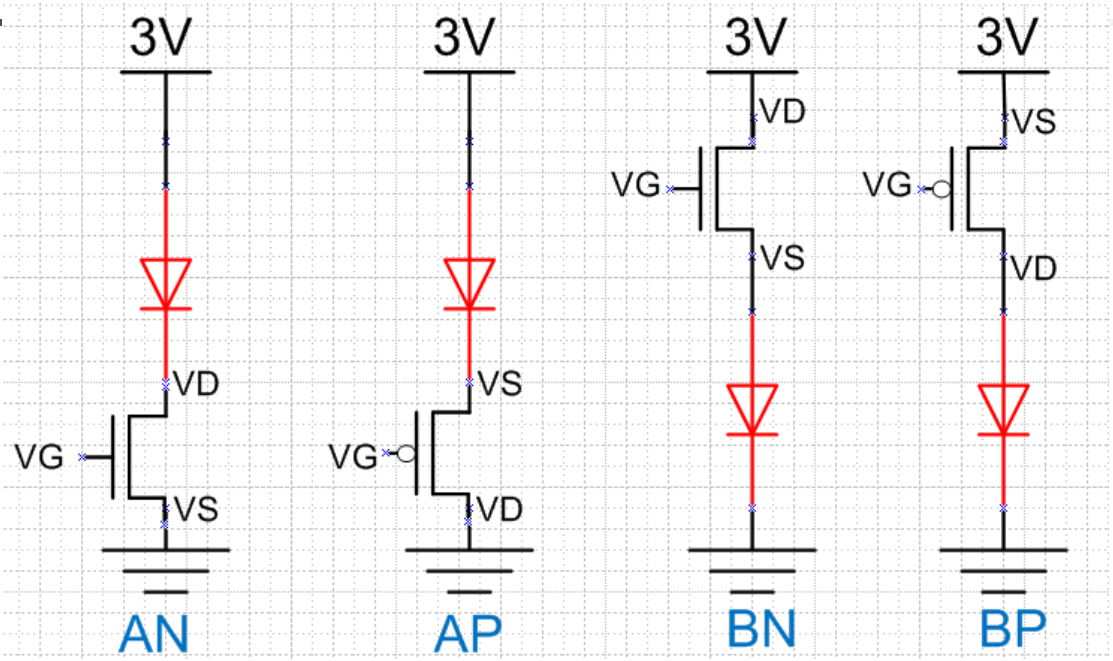
To switch on MOS, VGS must > Vth. Let assume Vth=0.8V.

For type AN: VG=3V, NMOS turn on. VD=0V.
0V is transfer to 0V. NMOS transfer logic 0 perfectly.

For type BN: VG=3V, NMOS turn on. But VS=2.2V due to Vth=0.8V.
3V is transfer to 2.2V. NMOS cannot transfer logic 1 perfectly.

How about PMOS?

PMOS transfer logic 1 perfectly



For type AP: VG=0V, PMOS turn on. VS-VG must be >Vth for PMOS to turn on. VS=0.8V
0V is transfer to 0.8V. PMOS cannot transfer logic 0 perfectly.

For type BP: VG=0V, PMOS turn on.
3V is transfer to 3V. PMOS transfer logic 1 perfectly.

Transmission Gate

NMOS can transfer logic 0 perfectly

PMOS can transfer logic 1 perfectly

Transmission Gate can transfer all logic (all logic? how many logic levels can we have?) perfectly.