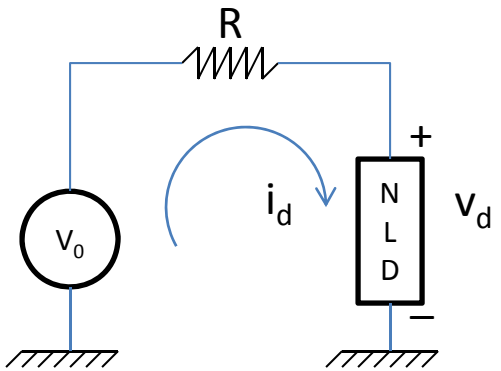
The Load Line Method

The load line method is a graphical method used to determine the operating point of a circuit, especially when nonlinear devices are present. Consider a nonlinear device (NLD) with the following current-voltage (I-V) characteristics:



$$i_d = f(v_d)$$

or

$$v_d = f(i_d)$$

where $f(.)$ is a general nonlinear, smooth function. Consider a polarization circuit comprising a supply voltage V_0 and a resistor R in series with the nonlinear device.

operating point

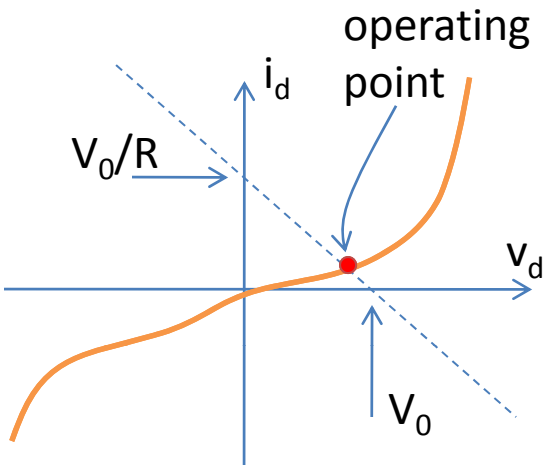
The operating point can be found by imposing the following system of equations

$$V_0 = Ri_d + v_d \quad (1)$$
$$i_d = f(v_d) \quad (2)$$

The system can be resolved graphically. The first equation is infact a line in a I-V plot, intersecting the voltage axis at $v_d = V_0$ and the current axis at $i_d = V_0/R$. The second equation is exactly the I-V characteristic equation of the nonlinear device (e.g. available from datasheets).

Similar considerations apply when the nonlinear device characteristics are expressed as

$$v_d = f(i_d)$$



example: temperature sensor

A typical application is with 3-terminal devices (e.g. transistors) or sensors whose response is modulated by a physical variable (e.g. light intensity, temperature, etc...).

Consider the case of the temperature sensor AD590, an optimal load R should chosen so that the operating point varies linearly with the input temperature.

Note: the best load line corresponds to the vertical line, i.e. $R \rightarrow 0$. This means $v_d = const$. In this case, a current-to-voltage amplifier should be used.