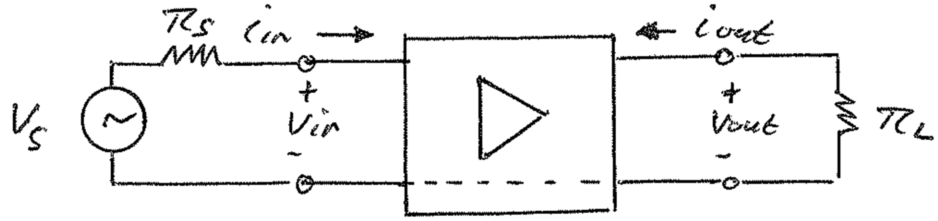
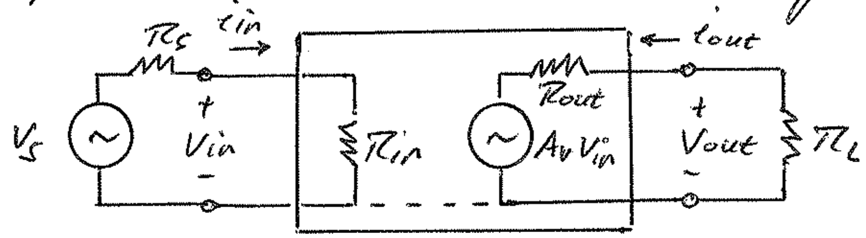
Amplifier Classification

Amplifiers feature an input and an output port and thus can be modeled as a 2-port



If we treat the amplifier as a box, we can only observe the input current i_{in}, the input voltage V_{in}, the output current i_{out} and the output voltage V_{out}. The interior circuitry of the amplifier can be modeled as follows:



The depicted parameters are defined as

$$A_V = \frac{V_{out}}{V_{in}} \qquad R_{in} = \left.\frac{V_{in}}{i_{in}}\right|_{R_L}$$

$$A_I = \frac{i_{out}}{i_{in}} \qquad R_{out} = \left.\frac{V_{out}}{i_{out}}\right|_{V_s = 0}$$

<u>Note:</u> V_s and R_s as well as R_L are frequently decoupled from the amplifier bias circuitry by capacitors, which only pass the AC signals.

Measuring R_{in} and R_{out}

R_{in} and R_{out} can readily be computed by replacing the amplifier circuit by a linear equivalent circuit and imposing the specific operating condition based on the definitions of R_{in} and R_{out}.

When measuring R_{in} and R_{out}, we have to make sure we are not altering the operating conditions of the amplifier. An effective way to measure R_{in} and R_{out} is to apply a single (AC) source V_S and record the open loop and closed loop voltage at the input and output, respectively. The unknown resistors R_{in} and R_{out} can then be computed as follows:

$$\left| \begin{array}{l} V_{in}\,(\text{open}) = V_S \\ V_{in}\,(\text{closed}) = V_S \cdot \dfrac{R_{in}}{R_S + R_{in}} \end{array} \right| \qquad \left\| R_{in} = R_S \, \frac{V_{in}(\text{closed})}{V_{in}(\text{open}) - V_{in}(\text{closed})} \right\|$$

and

$$\left| \begin{array}{l} V_{out}(\text{open}) = A_V \cdot V_{in} \\ V_{out}(\text{closed}) = A_V V_{in} \dfrac{R_L}{R_{out} + R_L} \end{array} \right| \qquad \left\| R_{out} = R_L \, \frac{V_{out}(\text{open}) - V_{out}(\text{closed})}{V_{out}(\text{open})} \right\|$$

For best accuracy select $R_S \approx R_{in}$ (expected)

$R_L \approx R_{out}$ (expected)