Sketch of the emitter-follower, a unity gain impedance buffer

This circuit can be understood by applying Kirchhoff's voltage law to the left-hand loop. We have:

\[-V_{in} + I_B R_B + V_{BE} + I_E R_E = 0.\]

In the linear regime, \(I_E = (1+\beta)I_B\) so:

\[V_{out} = I_E R_E = (V_{in} - V_{BE}) R_E / [R_E + R_B / (1+\beta)] \approx V_{in} - V_{BE}\]

since \(\beta \gg 1\). To within an offset of \(V_{BE}\), the magnitude of output is the same as the input.

The input resistance, found by opening the dependent current source \(I_c\) and shorting the voltage drop \(V_{BE}\), is just:

\[R_{in} = V_B / I_B = I_E R_E / I_B = (1+\beta) R_E.\]

So we see that the emitter-follower functions as a high impedance input.

The output resistance, found similarly by opening the dependent current source \(I_c\) and shorting the voltage sources \(V_{BE}\) and \(V_{in}\), is just

\[R_{out} = V_E / I_E = I_B R_B / I_E = R_B / (1+\beta).\]

This is just the resistance of the source divided by the gain.

Both relations generalize to

\[Z_{in} = (1+\beta) Z_E\] and \(Z_{out} = Z_{source}/(1+\beta).\)