BJT AMPLIFIERS

1. Two-port system
2. BJT configurations
3. Voltage Buffer
4. Current Buffer

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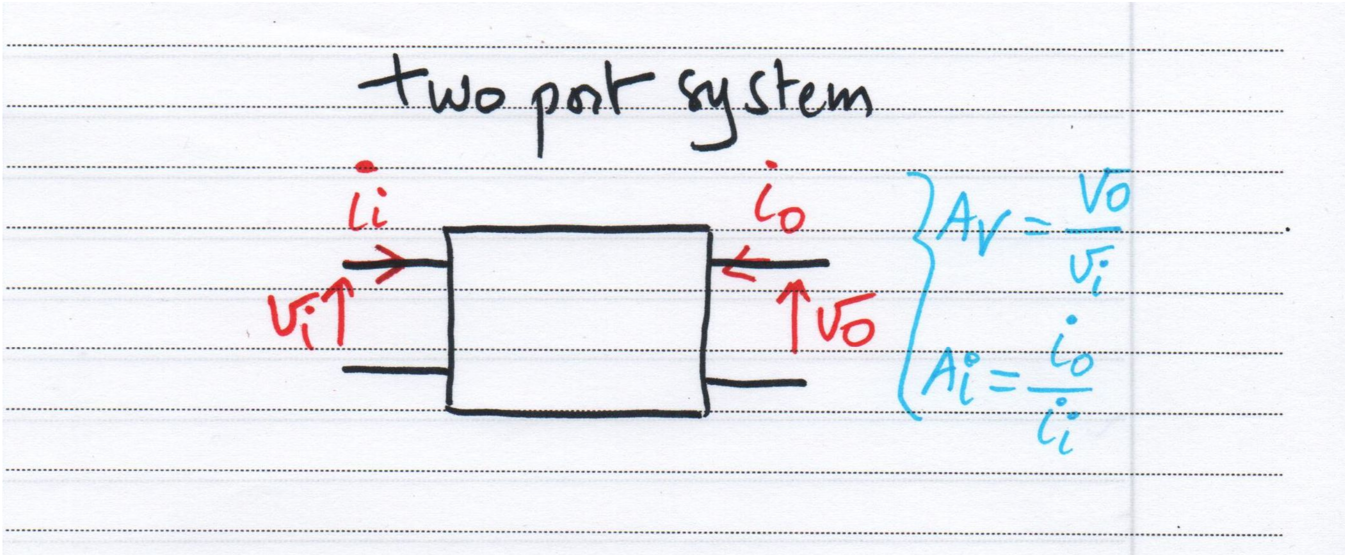
two port system
ii
io
vi
vo
Av = vo / vi
Ai = io / ii

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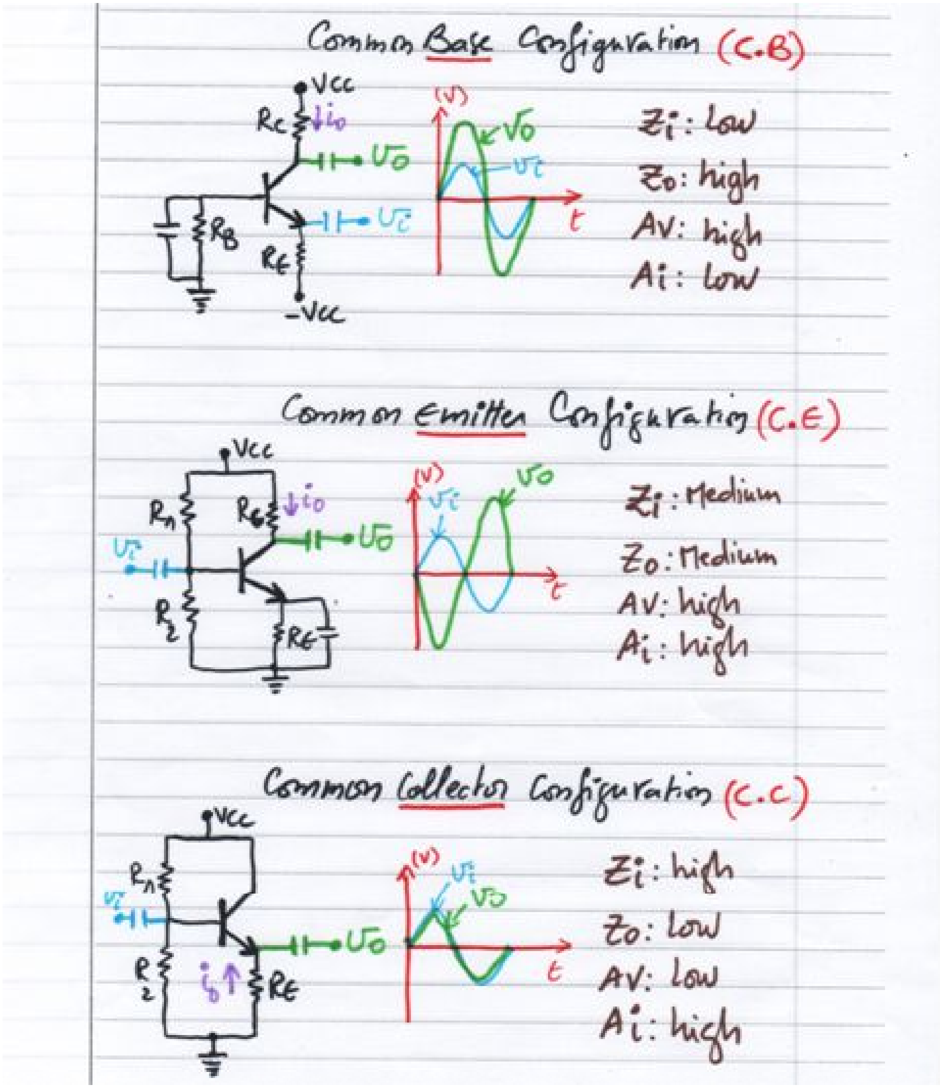
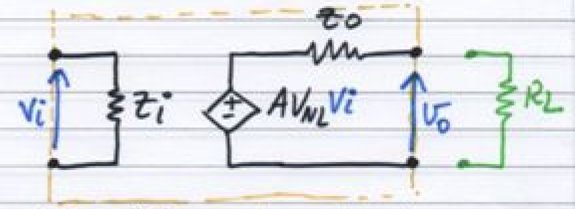
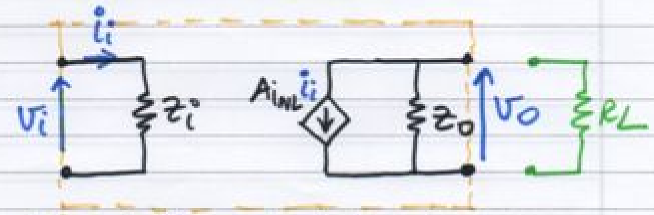

Common Base Configuration (C.B)
Vcc
Rc
i_o
v_o
v_i
R_B
R_E
-Vcc
(V)
v_o
v_i
t
Z_i: low
Z_o: high
Av: high
Ai: low
Common Emitter Configuration (C.E)
Vcc
R_1
R_C
i_o
v_o
v_i
R_2
R_E
(V)
v_i
v_o
t
Z_i: Medium
Z_o: Medium
Av: high
Ai: high
Common Collector Configuration (C.C)
Vcc
R_1
v_i
v_o
R_2
i_b
R_E
(V)
v_i
v_o
t
Z_i: high
Z_o: low
Av: low
Ai: high

BJT Amplifier using voltage dep. source



AV_{NL} : is The No-loaded gain in voltage.

BJT Amplifier using current dep. source



Ai_{NL} : is The No loaded gain in current.

In The case of (common base config)

$Ai_{NL} \simeq -1$

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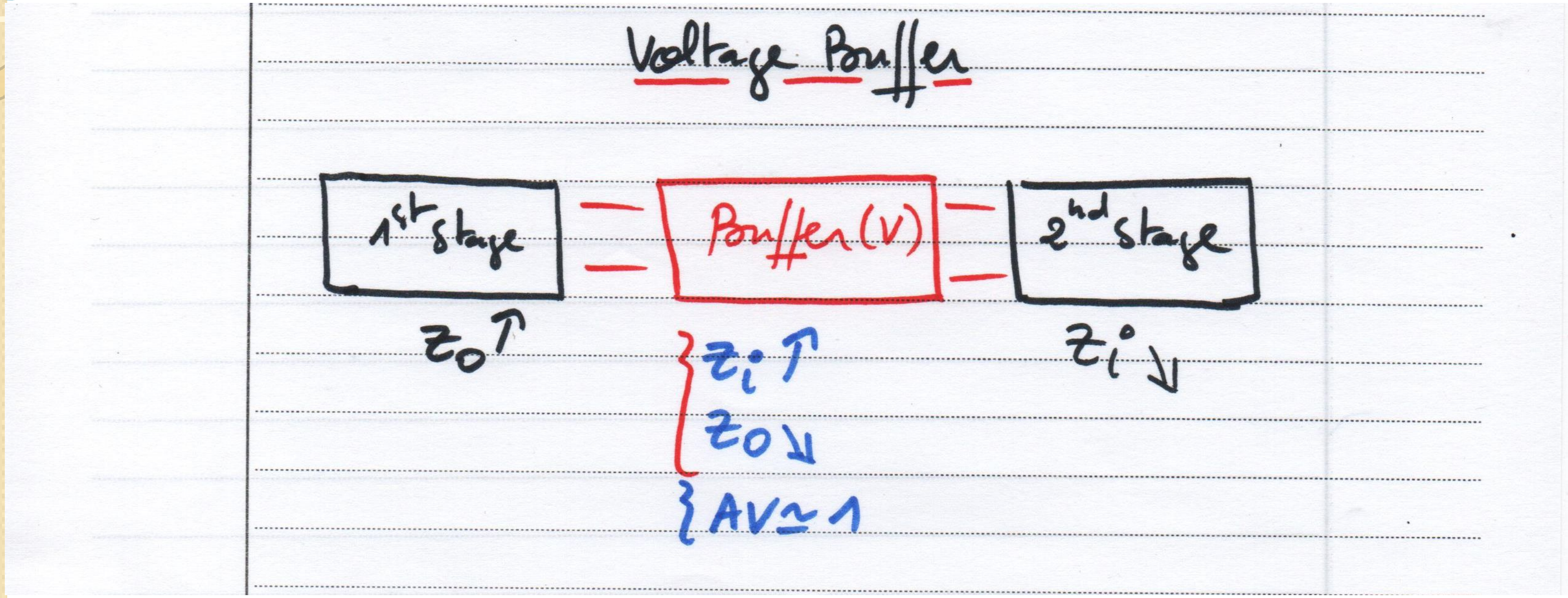
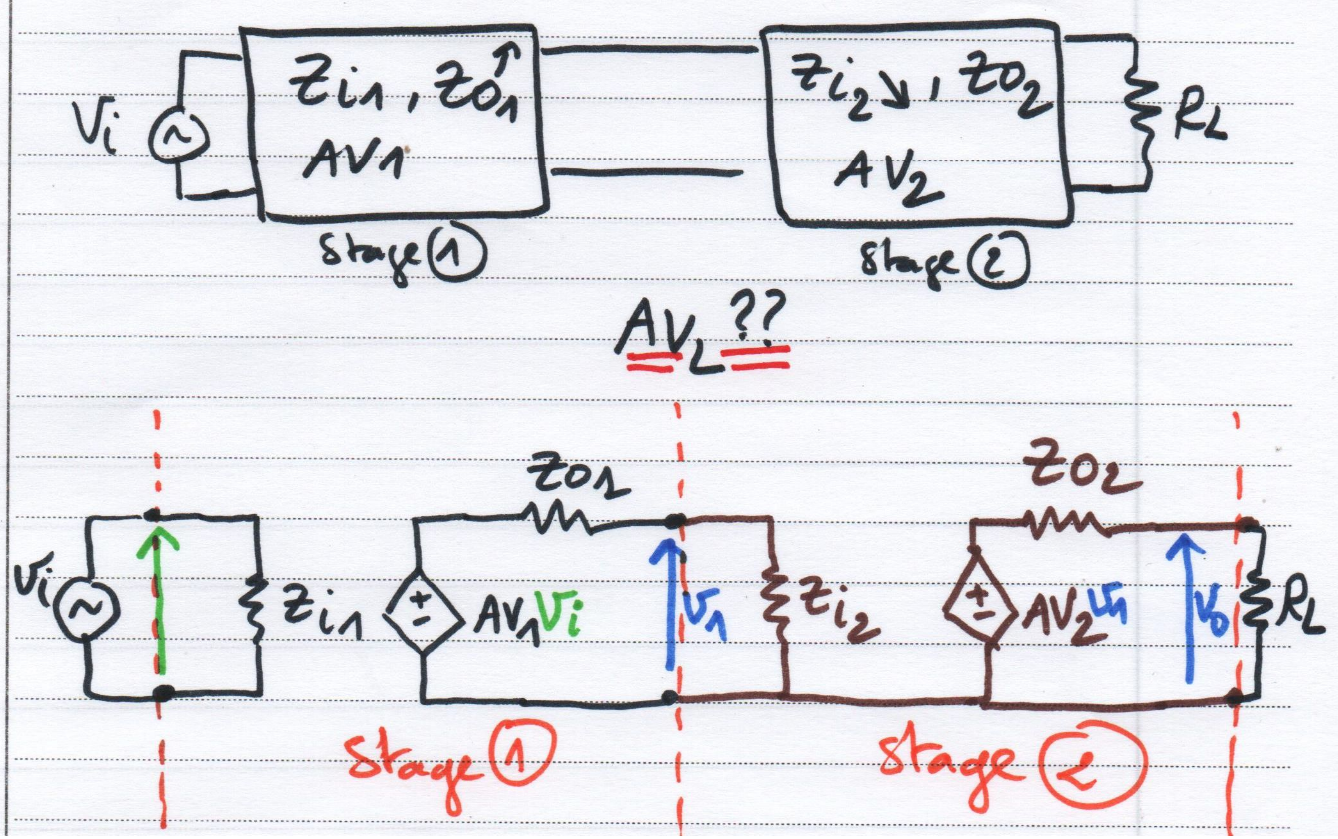

Voltage Buffer
1st stage
Buffer (V)
2nd stage
Zo ↑
Zi ↑
Zo ↓
AV ≃ 1
Zi ↓

Application :



$$V_1 = \frac{Z_{i_2}}{Z_{i_2} + Z_{o_1}} A_{V_1} V_i \quad \dots (1)$$

$$V_0 = \frac{R_L}{R_L + Z_{o_2}} A_{V_2} V_1 \quad \dots (2)$$

(1) in (2):

$$V_0 = \frac{R_L}{R_L + Z_{o_2}} \times \frac{Z_{i_2}}{Z_{i_2} + Z_{o_1}} A_{V_1} A_{V_2} V_i$$

$$A_{V_L} = \frac{V_0}{V_i} = \frac{R_L}{R_L + Z_{o_2}} \times \frac{Z_{i_2}}{Z_{i_2} + Z_{o_1}} \times A_{V_1} \times A_{V_2}$$

If we suppose: $Zo_2 = M$, $R_L = M$

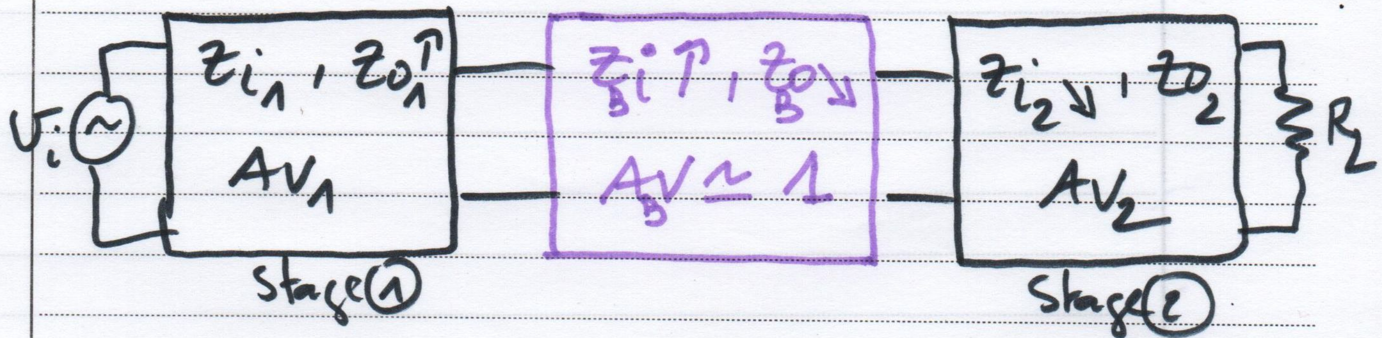
with: $Zo_1 = H$, $Zi_2 = L$

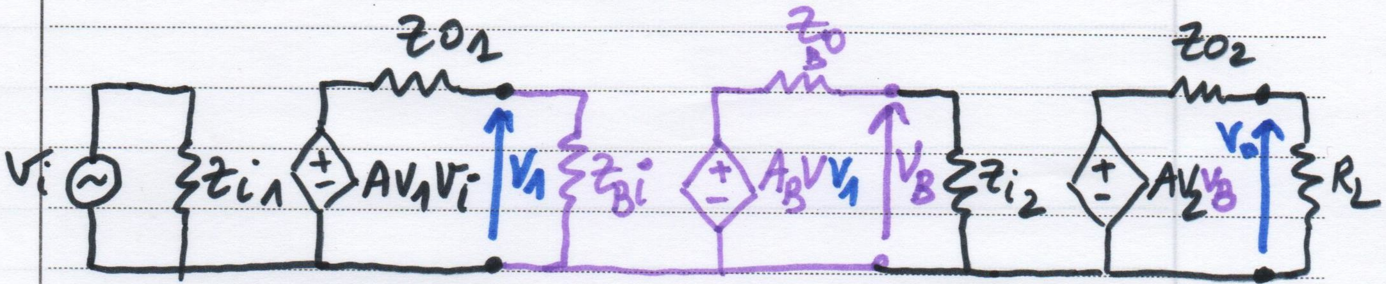
$$AV_L = \underbrace{\frac{R_L \nearrow M}{\underset{\searrow M}{R_L} + \underset{\searrow M}{Zo_2}}}_{\simeq 1/2} \times \underbrace{\frac{Zi_2 \nearrow L}{\underset{\downarrow L}{Zi_2} + \underset{\downarrow H}{Zo_1}}}_{\simeq 0} \times AV_1 \times AV_2$$

$$\Downarrow$$

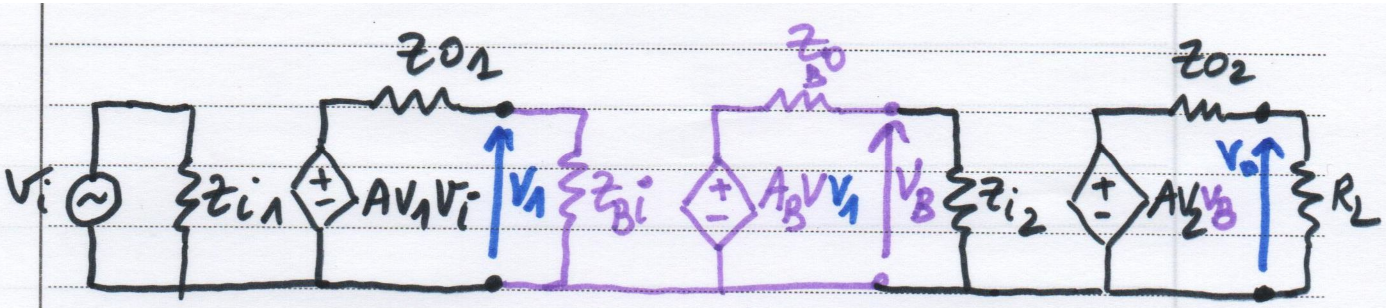
$$\boxed{AV_L \simeq 0}$$

Solution ⇒ Adding a Voltage Buffer





The new AV_L ??



The new AV_L ??

$$V_o = \frac{R_L}{Z_{o2} + R_L} AV_2 V_B \quad \ldots (1)$$

$$V_B = \frac{Z_{i2}}{Z_{i2} + Z_{Bo}} A_B V V_1 \quad \ldots (2)$$

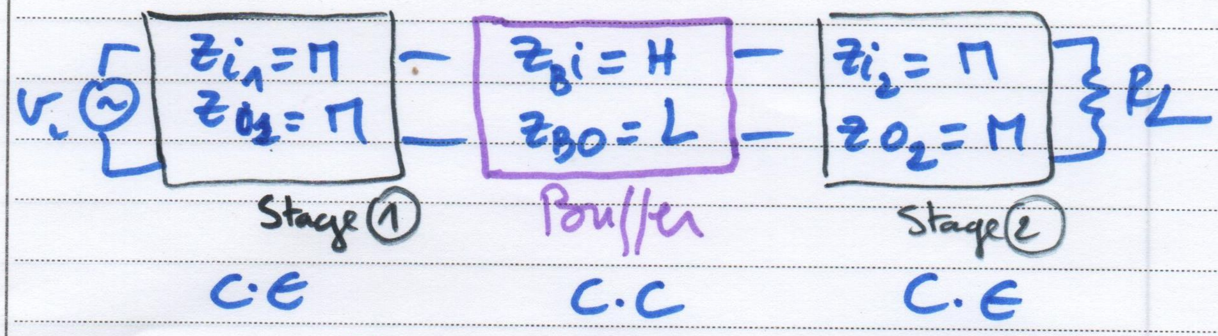
$$V_1 = \frac{Z_{Bi}}{Z_{Bi} + Z_{o1}} AV_1 V_i \quad \ldots (3)$$

3 in 2 and 2 in 1 $\Longrightarrow$

$$A_{V_L} = \frac{V_o}{V_i} = \underbrace{\frac{\overset{M}{R_L}}{\underset{M}{Z_{o_2}} + \underset{M}{R_L}}}_{\simeq 1/2} \times \underbrace{\frac{\overset{L}{Z_{i_2}}}{\underset{L}{Z_{i_2}} + \underset{L}{Z_{BO}}}}_{\simeq 1/2} \times \underbrace{\frac{\overset{H}{Z_{Bi}}}{\underset{H}{Z_{Bi}} + \underset{H}{Z_{o_1}}}}_{\simeq 1/2} A_{V_1} \times A_{V_2} \times \underset{1}{A_{BV}}$$

$$A_{V_L} \neq 0$$

Example:



$$A_{V_L} = \frac{v_o}{v_i} = \underbrace{\frac{\overset{\to M}{R_L}}{\underset{M}{Z_{o_2}} + \underset{M}{R_L}}}_{\simeq 1/2} \times \underbrace{\frac{\overset{\to M}{Z_{i_2}}}{\underset{M}{Z_{i_2}} + \underset{L}{Z_{BO}}}}_{\simeq 1} \times \underbrace{\frac{\overset{\to H}{Z_{Bi}}}{\underset{H}{Z_{Bi}} + \underset{M}{Z_{o_1}}}}_{\simeq 1} A_{V_1} A_{V_2} \underset{1}{\underset{=}{A_{BV}}}$$

A_{V_L} (without buffer) $\simeq 0$

$$A_{V_L} \text{ (with buffer)} \simeq \frac{R_L}{Z_{o_2} + R_L} A_{V_1} \times A_{V_2}$$

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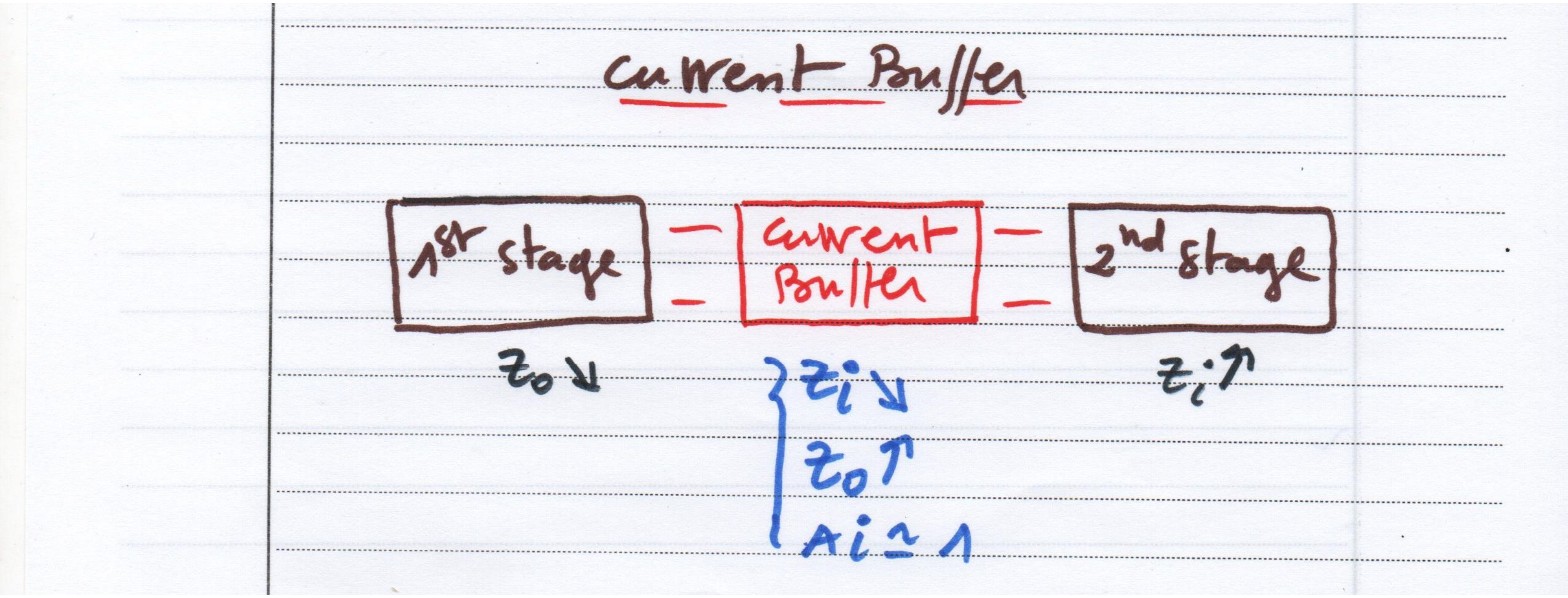
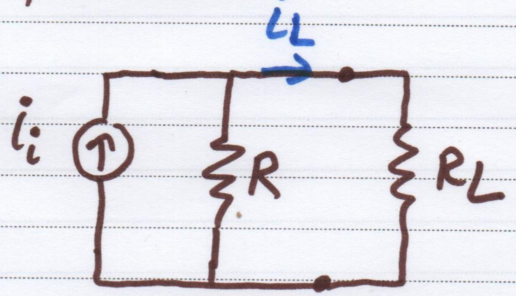

Current Buffer
1st stage
Current Buffer
2nd stage
$Z_o \searrow$
$Z_i \searrow$
$Z_o \nearrow$
$A_i \simeq 1$
$Z_i \nearrow$

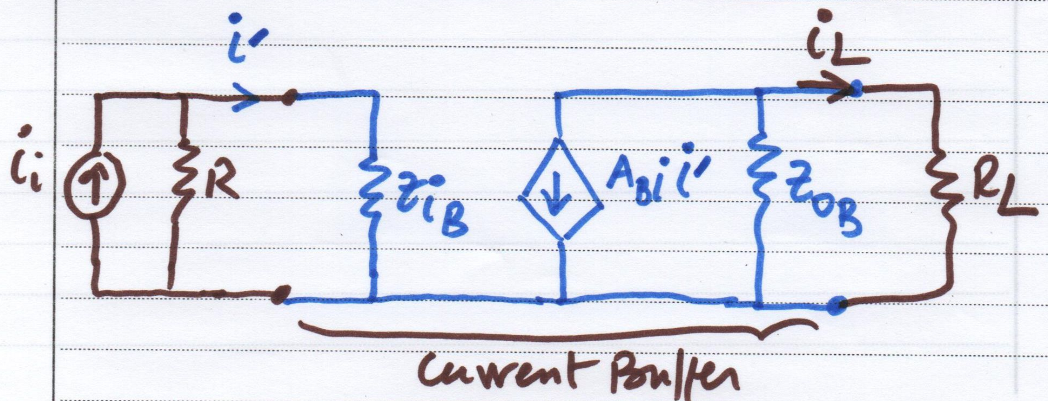
Application



$$i_L = \frac{R}{R+R_L}\, i_i$$

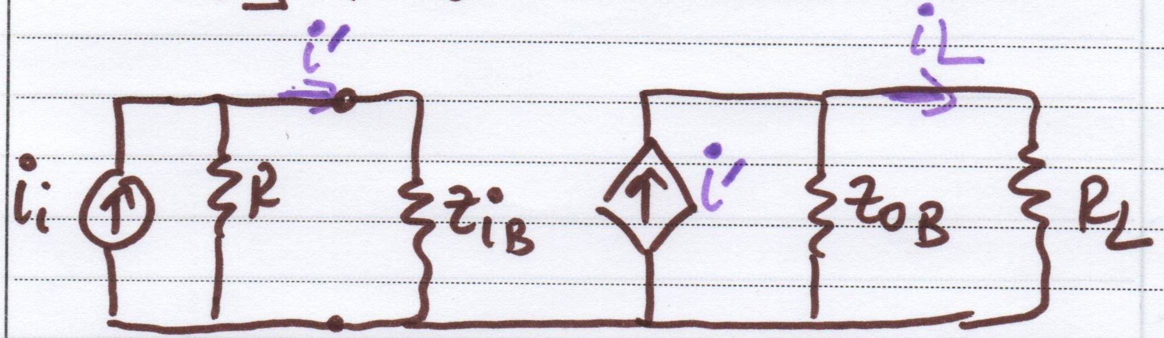
If $R_L \nearrow$ and $R \searrow$ $\Rightarrow$ $i_L \simeq 0$

$\Rightarrow$ To increase the level of the output current we have to add a current Buffer



Current Buffer ⇒ Common base configuration

$z_i \searrow$, $z_o \nearrow$ and $A_i \simeq -1$



$$i_L = \frac{z_{oB}}{z_{oB} + R_L} i' \quad \dots (1)$$

$$i' = \frac{R}{R + z_{iB}} i_i \quad \dots (2)$$

(2) in (1)

$$i_L = \underbrace{\frac{Z_{oB}^{\nearrow H}}{\underset{H}{Z_{oB}} + \underset{H}{R_L}}}_{1/2} \times \underbrace{\frac{R^{\nearrow L}}{\underset{L}{R} + \underset{L}{Z_{iB}}}}_{1/2} \, i_i$$

The best Case: $R = M$ and $R_L = M$

$$i_L \simeq i_i$$