

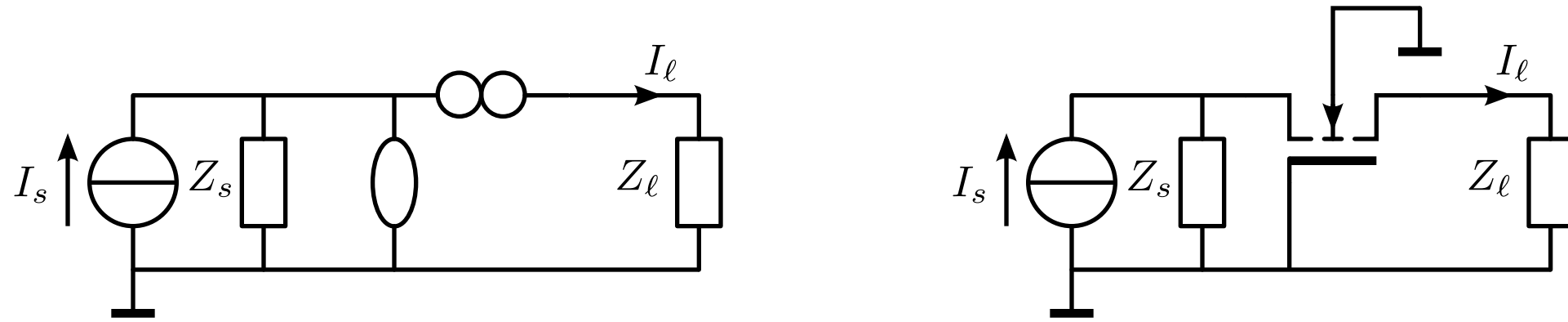
Structured Electronic Design

Common Gate Stage

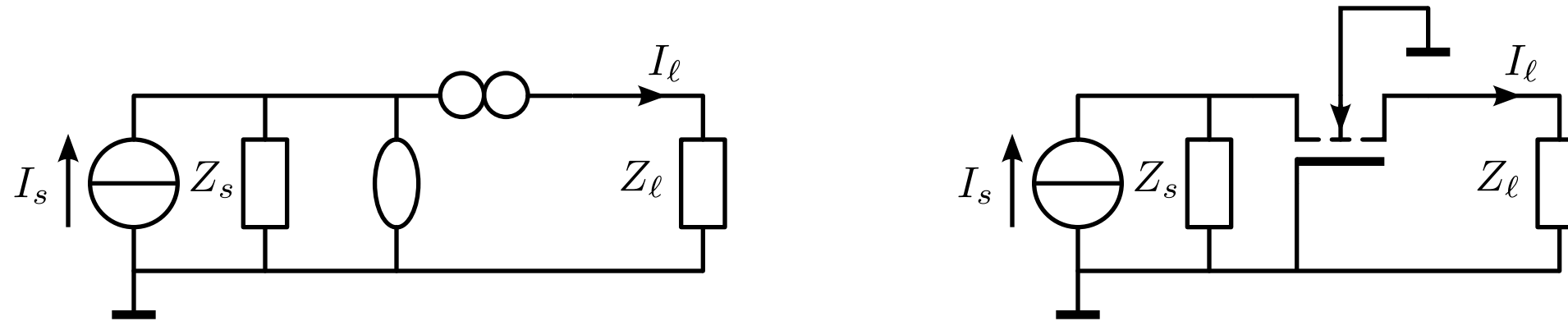
Anton J.M. Montagne

CG stage introduction

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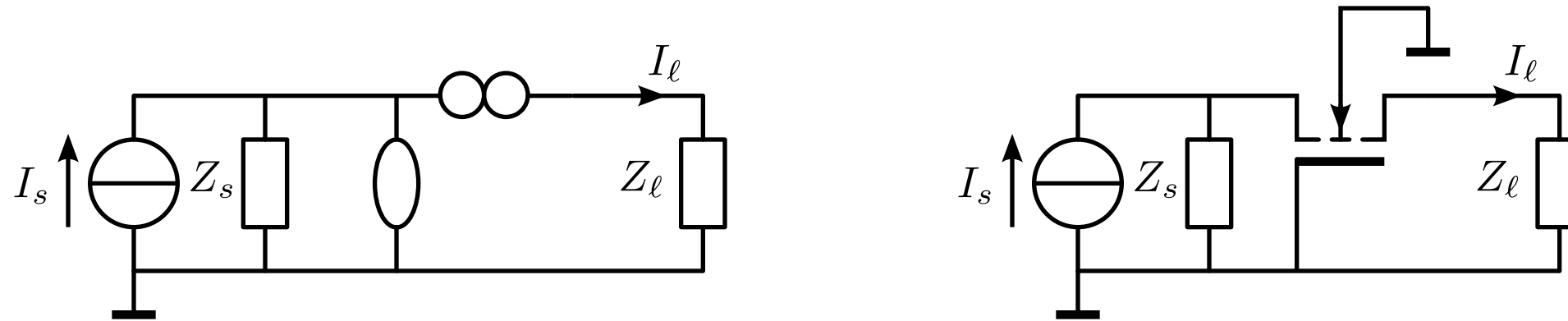


CG stage introduction



Nonenergetic feedback stage:

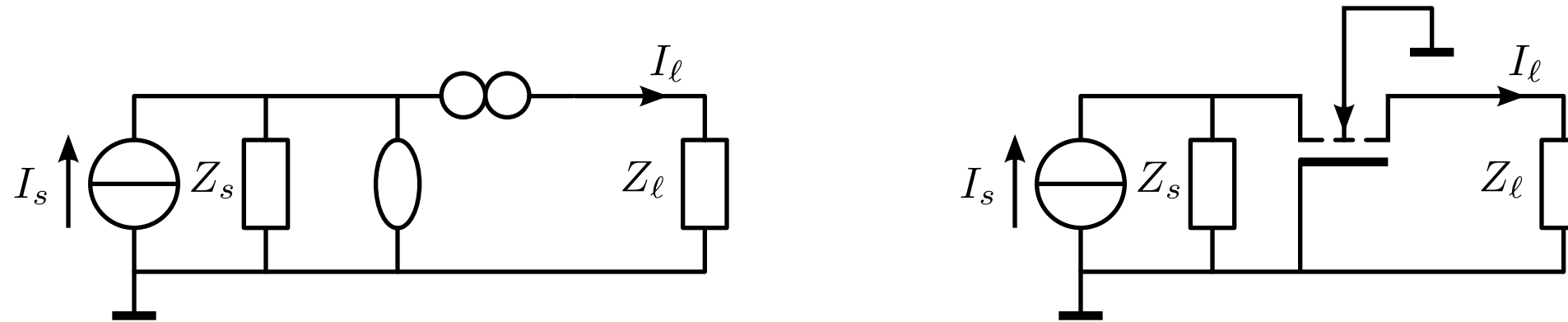
CG stage introduction



Nonenergetic feedback stage:

Current follower: $D = +1$, A, B, C as CS stage (noninverting)

CG stage introduction

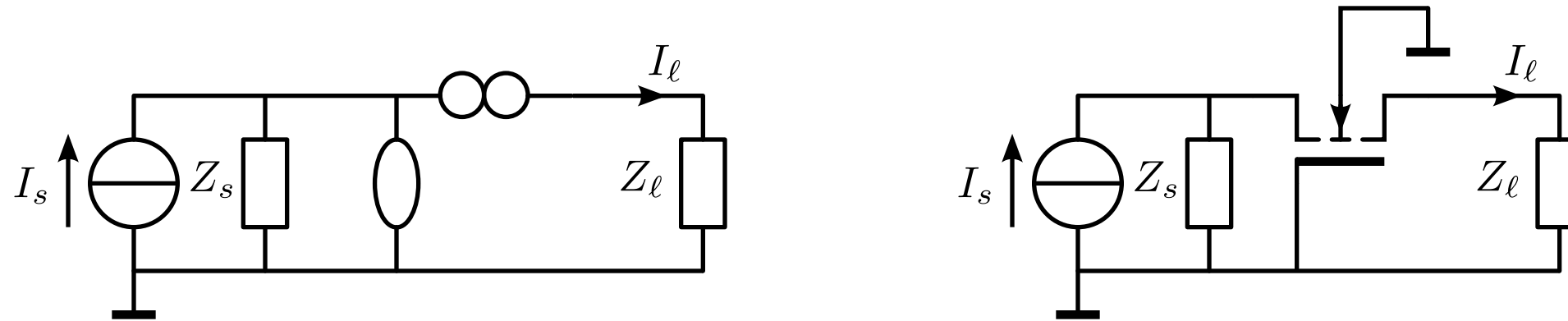


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Input parallel (shunt) feedback (current comparison)

CG stage introduction



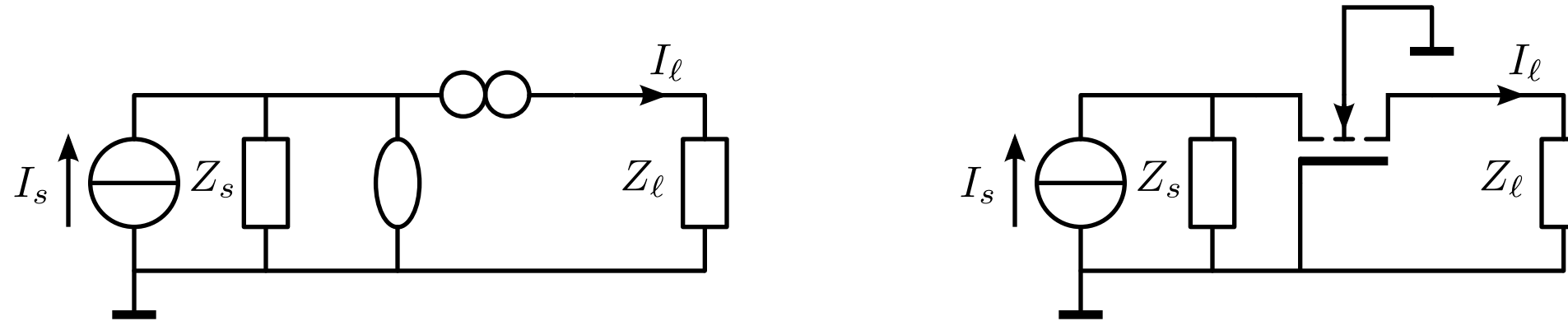
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Input parallel (shunt) feedback (current comparison)

Output series feedback (current sensing)

CG stage introduction



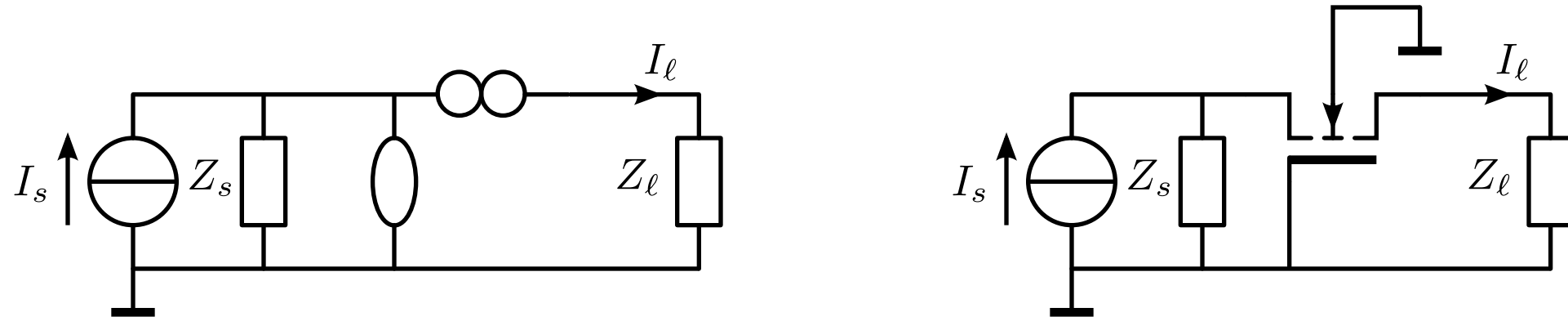
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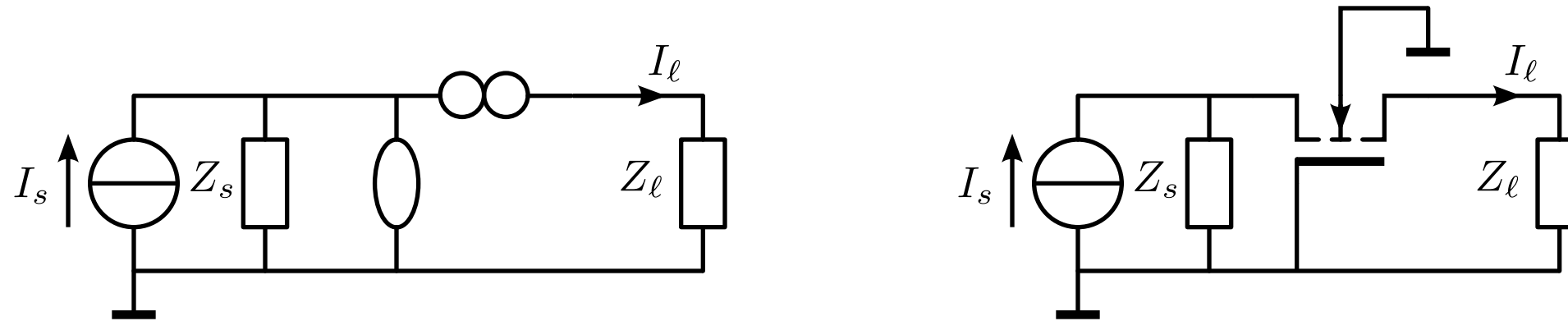
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Output series feedback (current sensing)

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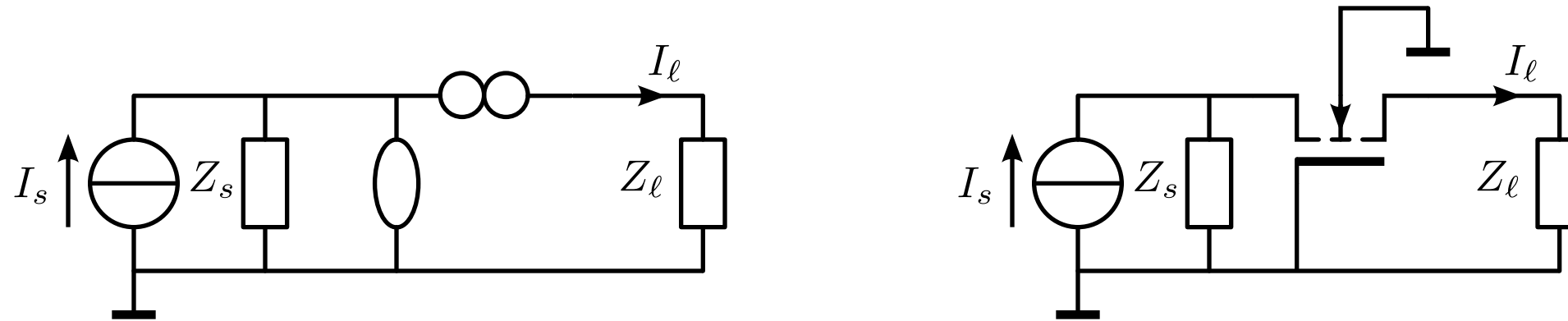


CG stage introduction



Behavioral modifications w.r.t. CS stage are a result of negative feedback:

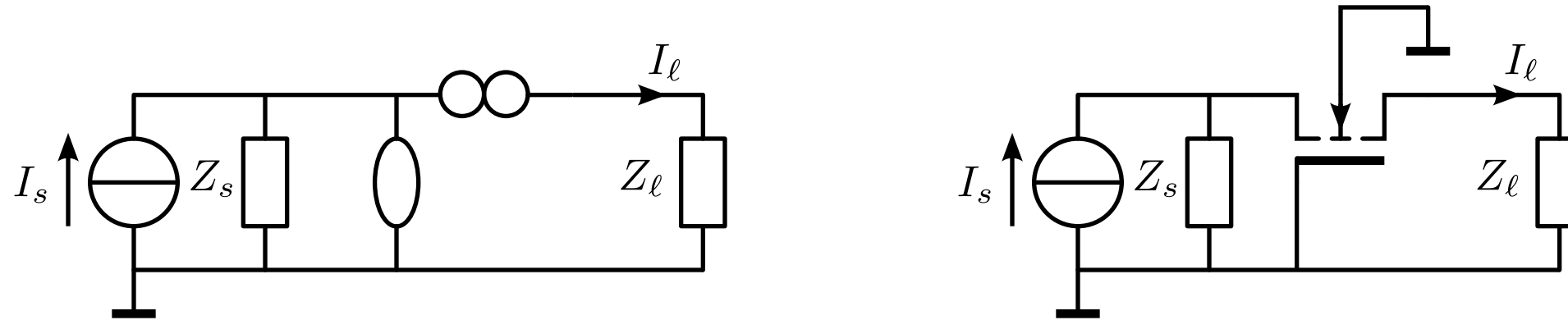
CG stage introduction



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CG stage introduction

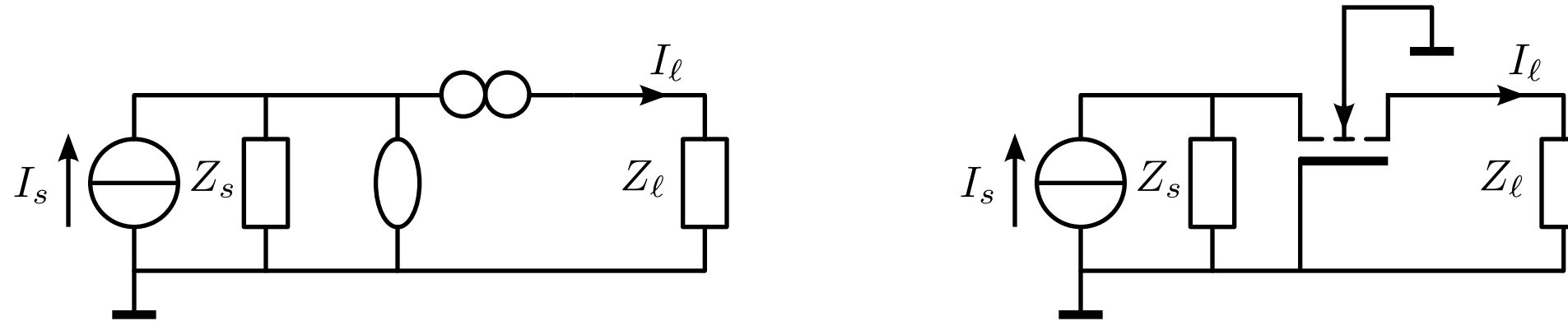


Behavioral modifications w.r.t. CS stage are a result of negative feedback:

Nonenergetic feedback:

The equivalent input noise sources of the CG stage equal those of the CS stage

CG stage introduction



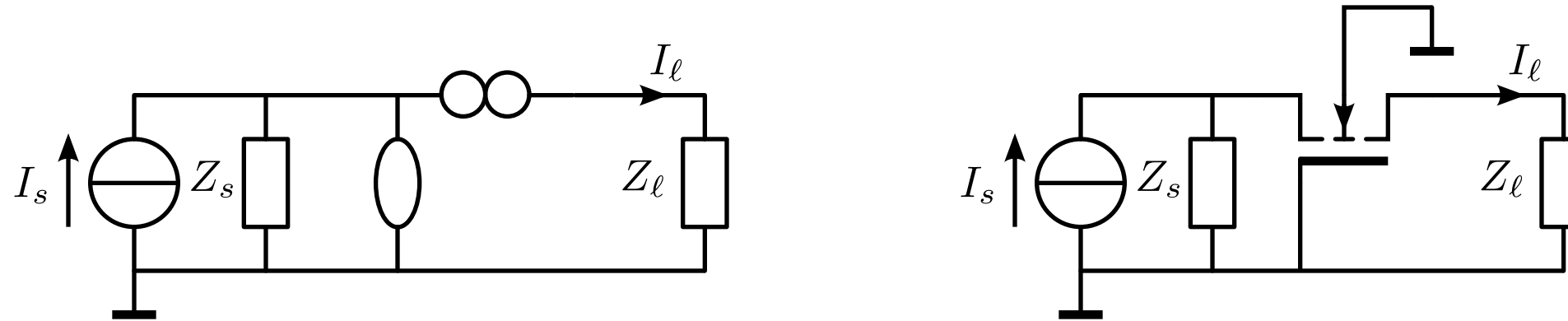
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The drive capability, energy storage and power efficiency equal those of the CS stage

CG stage introduction



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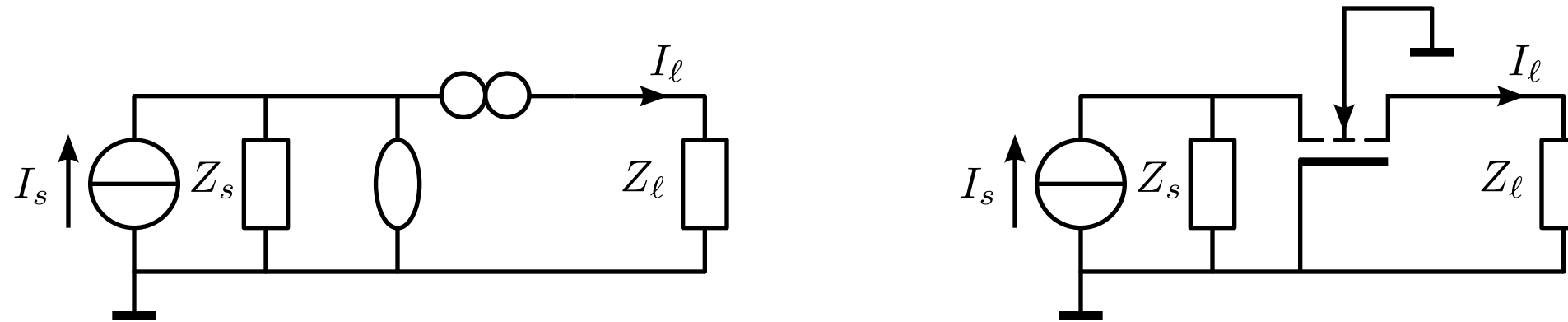
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The 'amount of feedback' is expressed by the loop gain

CG stage introduction



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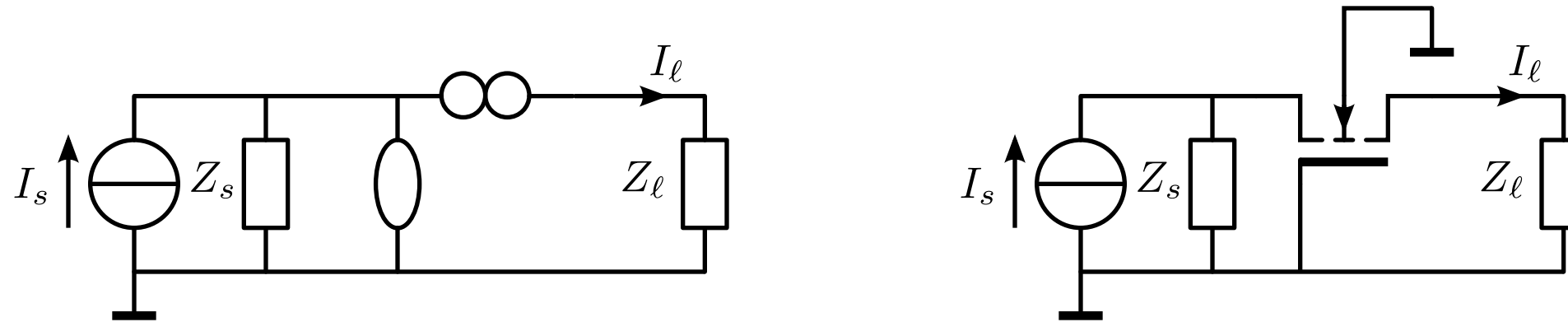
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The drive capability, energy storage and power efficiency equal those of the CS stage

The 'amount of feedback' is expressed by the loop gain

If terminated with a relatively high impedance or left open, the output series feedback is not effective (low loop gain) and the input impedance approximates that of the CS stage

CG stage introduction



Behavioral modifications w.r.t. CS stage are a result of negative feedback:

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The equivalent input noise sources of the CG stage equal those of the CS stage

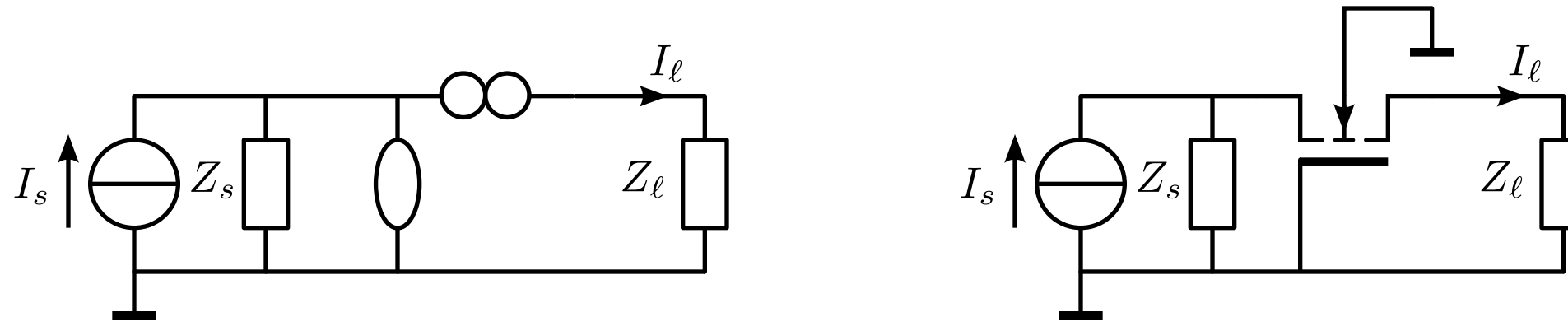
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The 'amount of feedback' is expressed by the loop gain

If terminated with a relatively high impedance or left open, the output series feedback is not effective (low loop gain) and the input impedance approximates that of the CS stage

If driven from a low impedance or if the input is shorted, the input parallel comparison is not effective (low loop gain) and the output impedance approximates that of the CS stage

CG stage introduction



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Nonenergetic feedback:

The equivalent input noise sources of the CG stage equal those of the CS stage

The drive capability, energy storage and power efficiency equal those of the CS stage

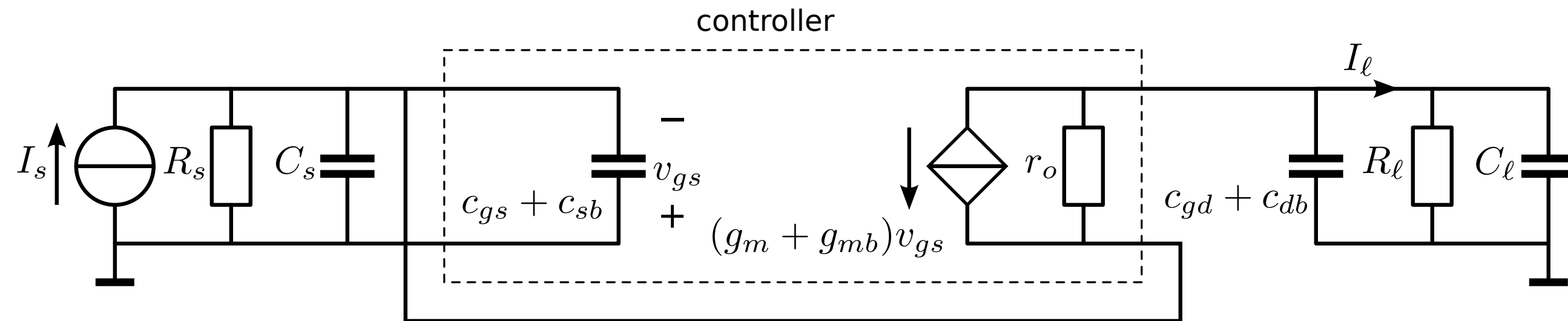
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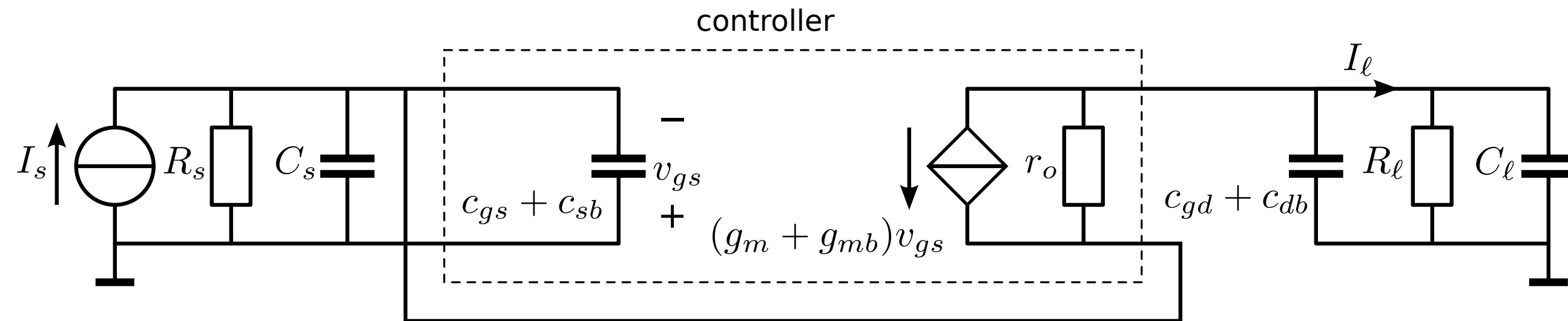
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CG stage ideal gain and asymptotic gain

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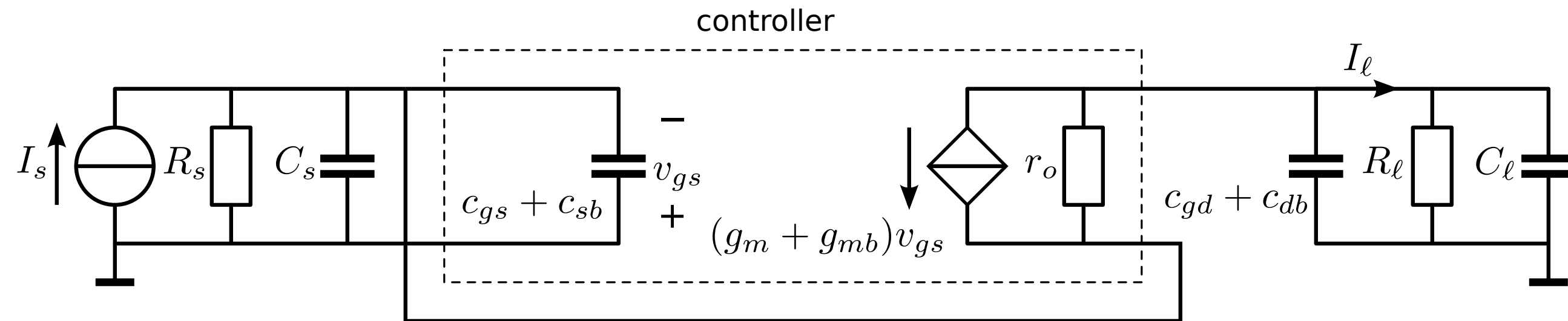


CG stage ideal gain and asymptotic gain



Ideal gain:

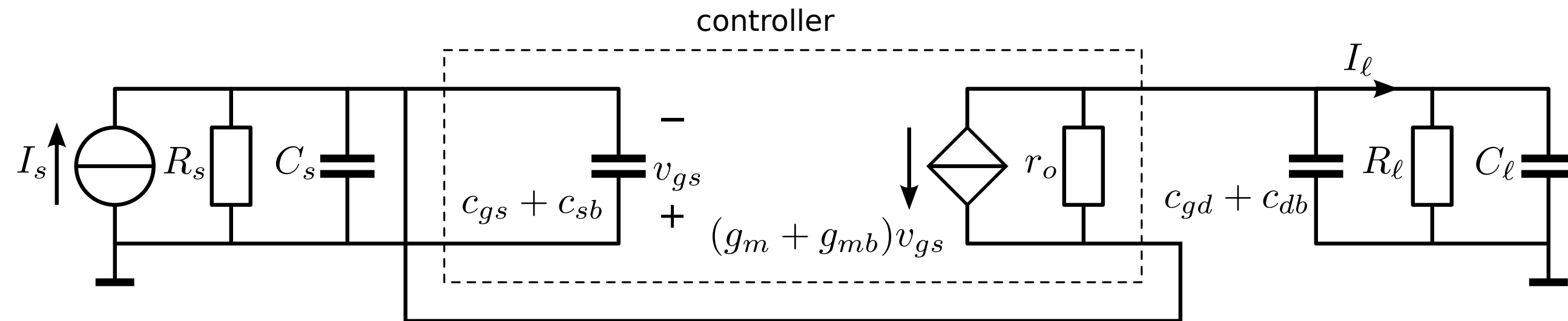
CG stage ideal gain and asymptotic gain



Ideal gain:

Gain if controller is
replaced with a nullor:

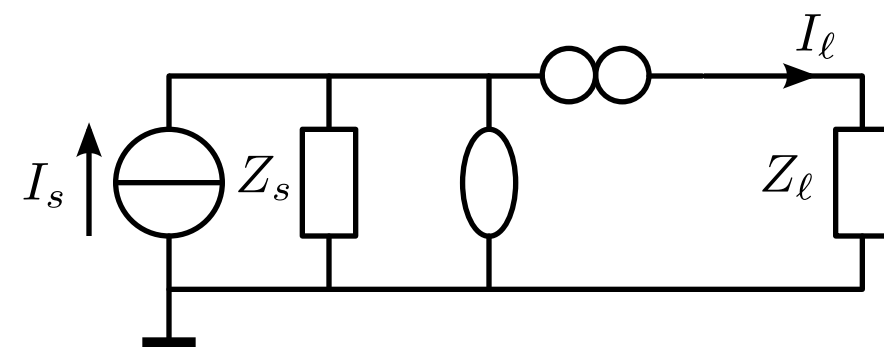
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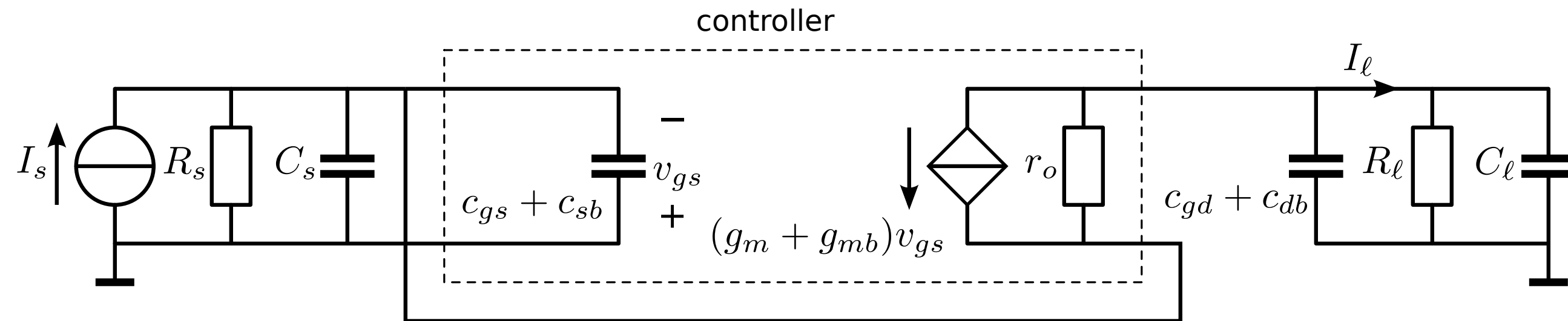
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Gain if controller is replaced with a nullor:

$$\frac{I_\ell}{I_s} = 1$$



CG stage ideal gain and asymptotic gain

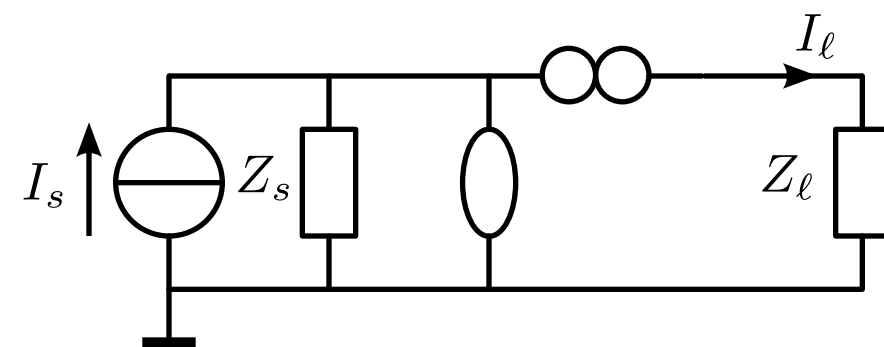


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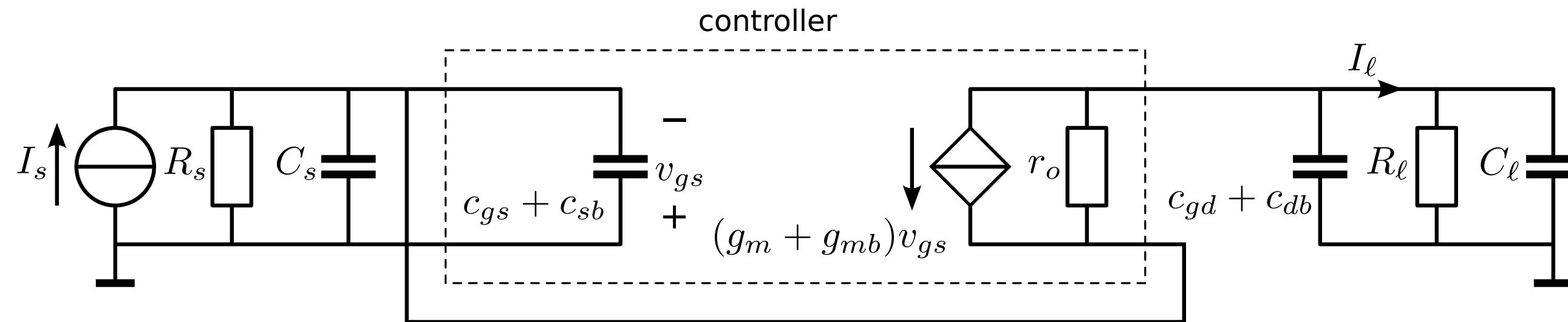
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Asymptotic gain:



CG stage ideal gain and asymptotic gain



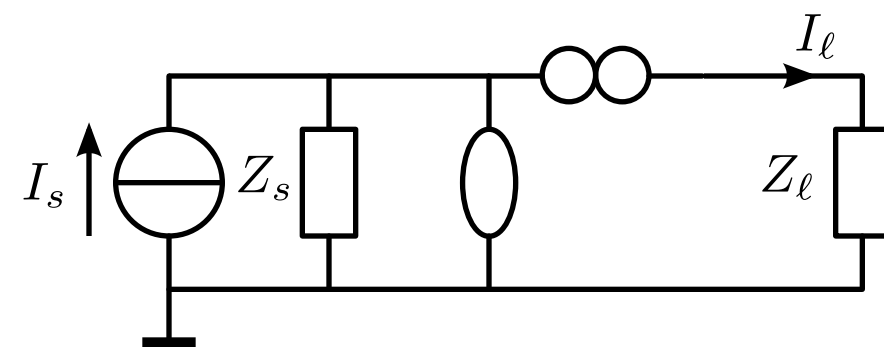
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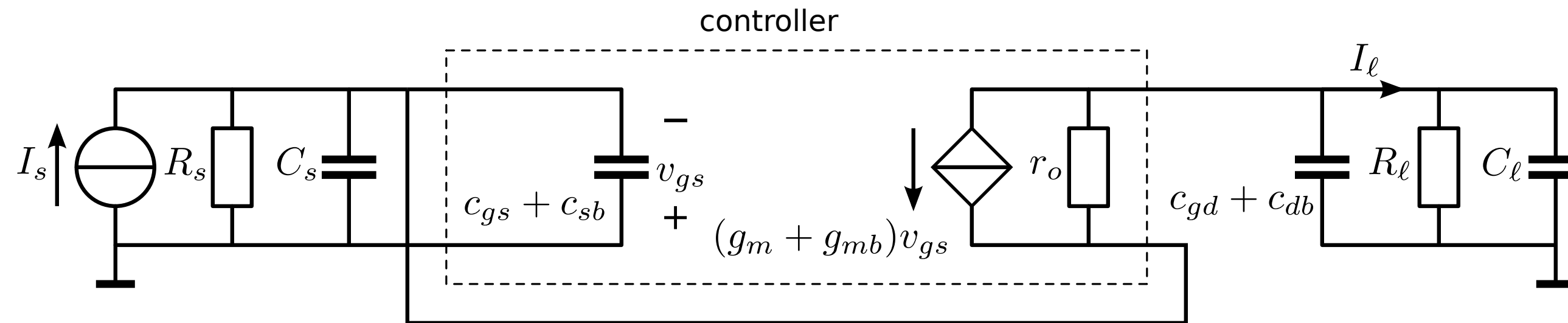
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Asymptotic gain:

Gain if controller is loop gain reference is replaced with a nullor:



CG stage ideal gain and asymptotic gain



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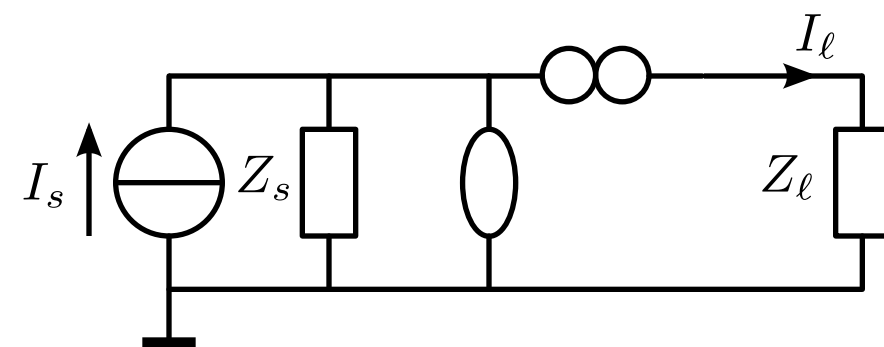
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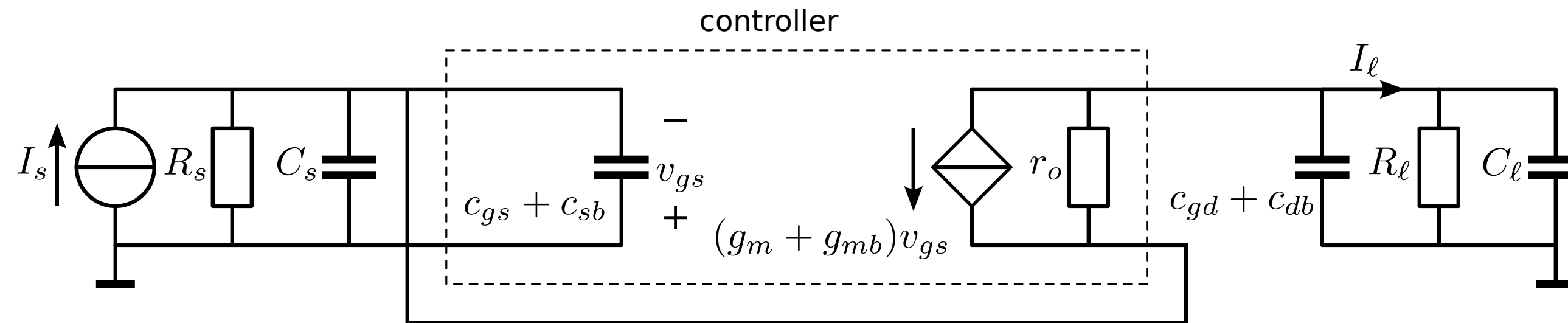
Asymptotic gain:

Gain if controller is loop gain reference is replaced with a nullor:

$$\frac{I_\ell}{I_s} = \frac{1 + sR_\ell C_\ell}{1 + sR_\ell (C_\ell + c_{gd} + c_{db})}$$



CG stage ideal gain and asymptotic gain



Ideal gain:

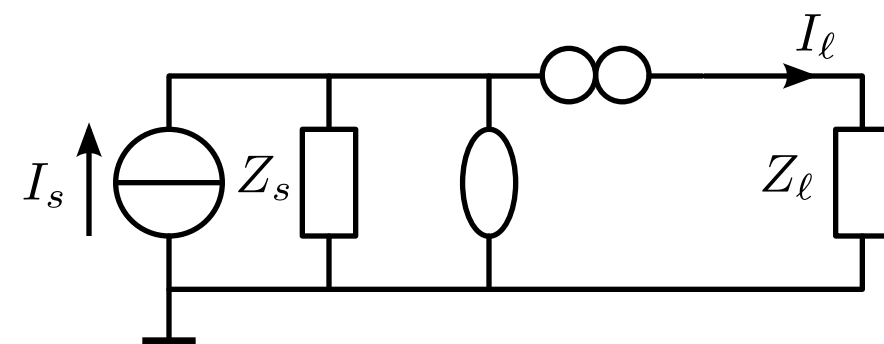
Gain if controller is replaced with a nullor:

$$\frac{I_\ell}{I_s} = 1$$

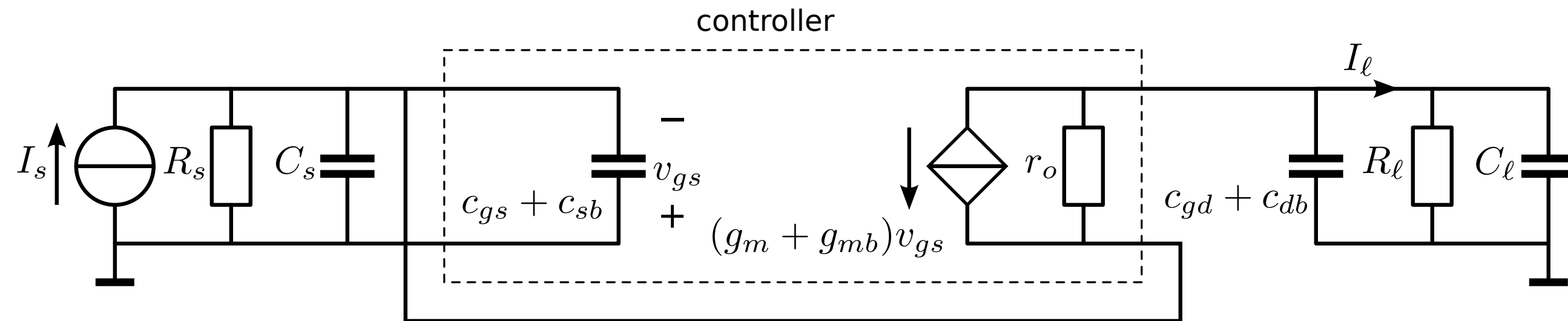
Asymptotic gain:

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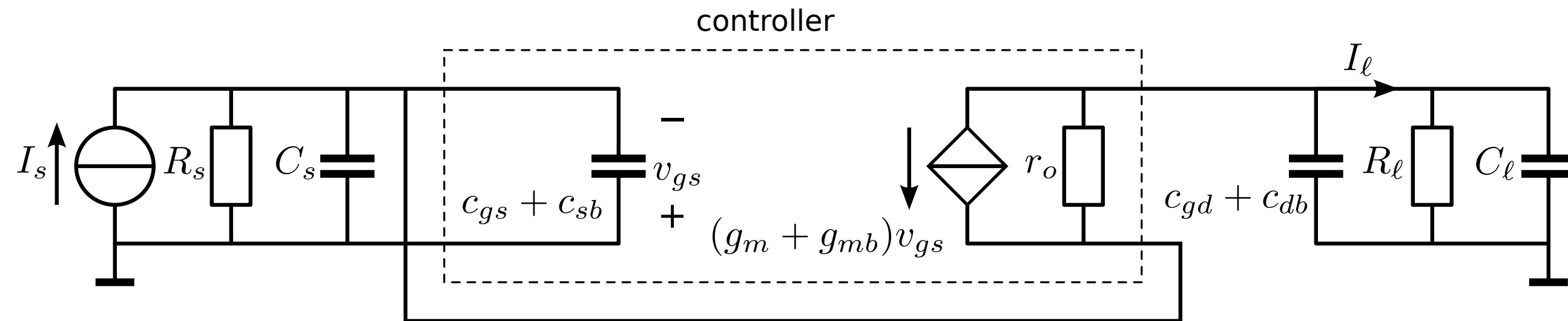
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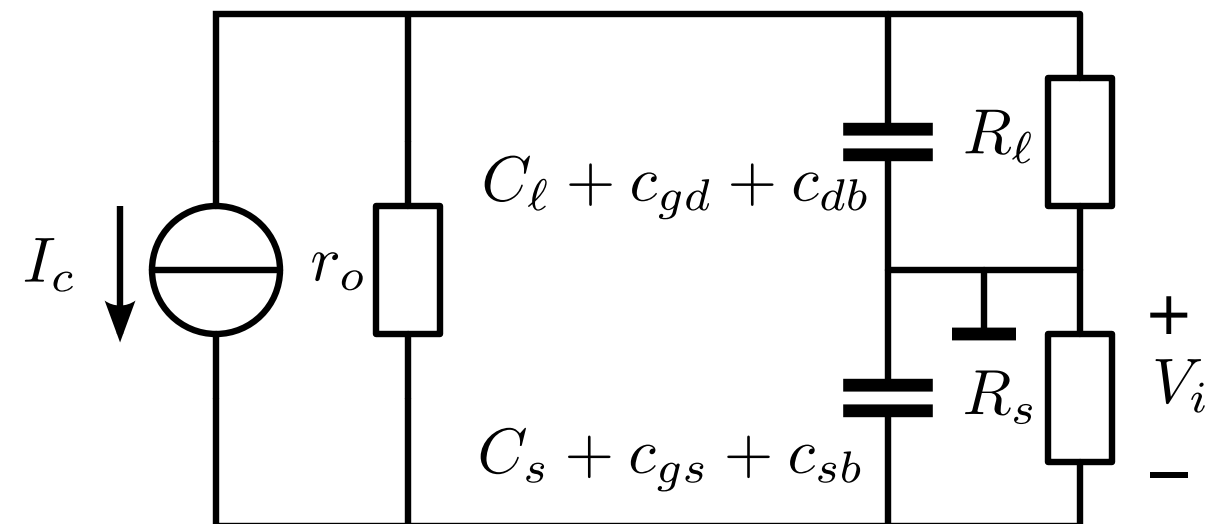
CG stage loop gain



CG stage loop gain

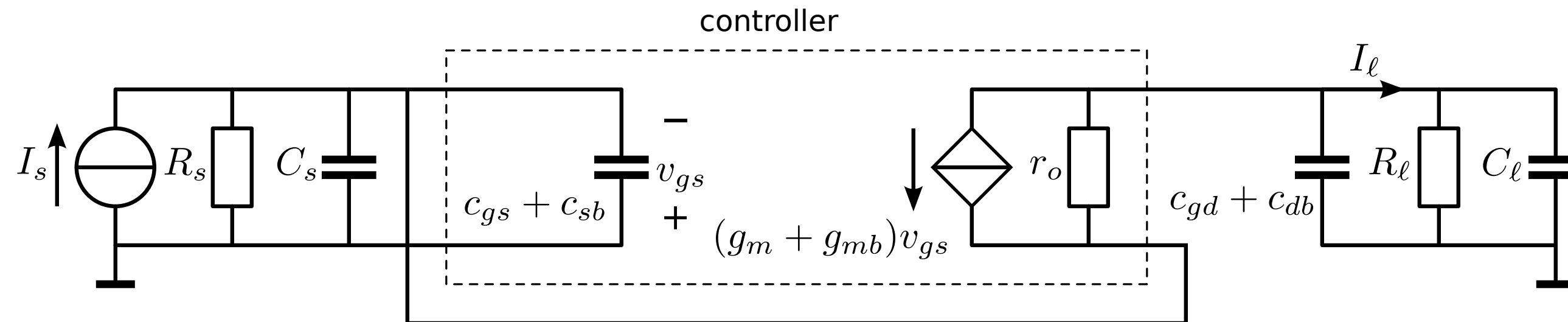


Loop gain:

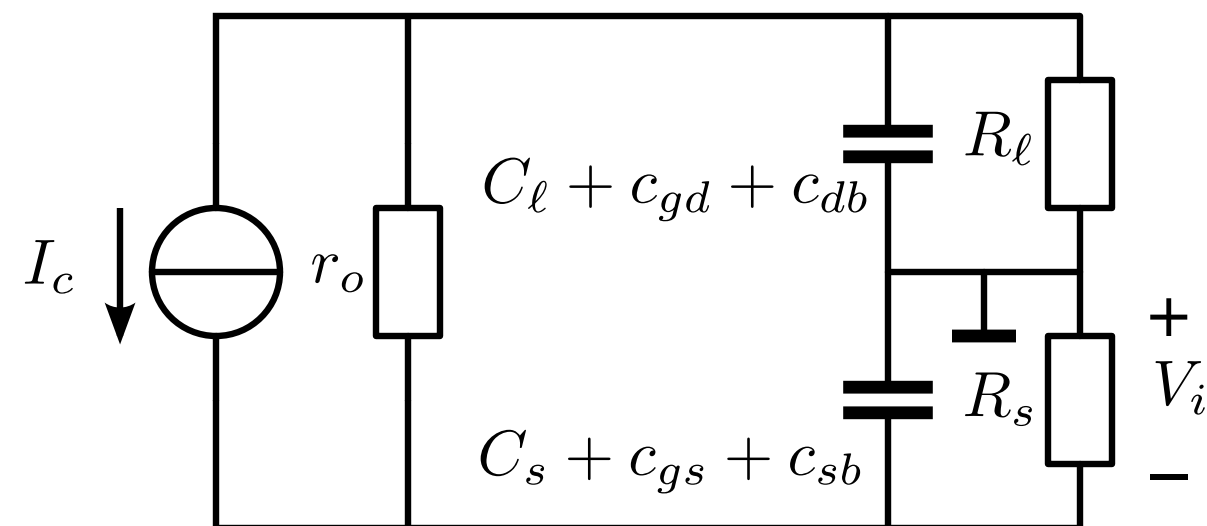


$$L = (g_m + g_{mb}) \frac{V_i}{I_c}$$

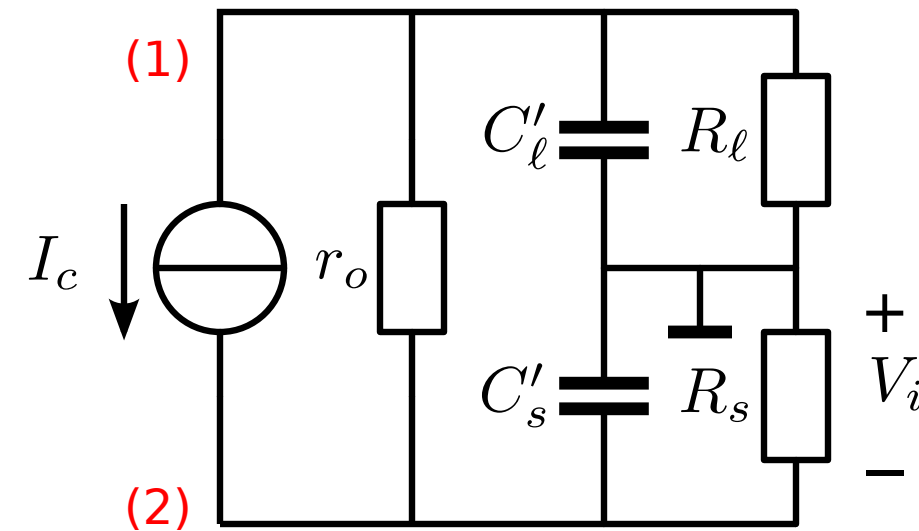
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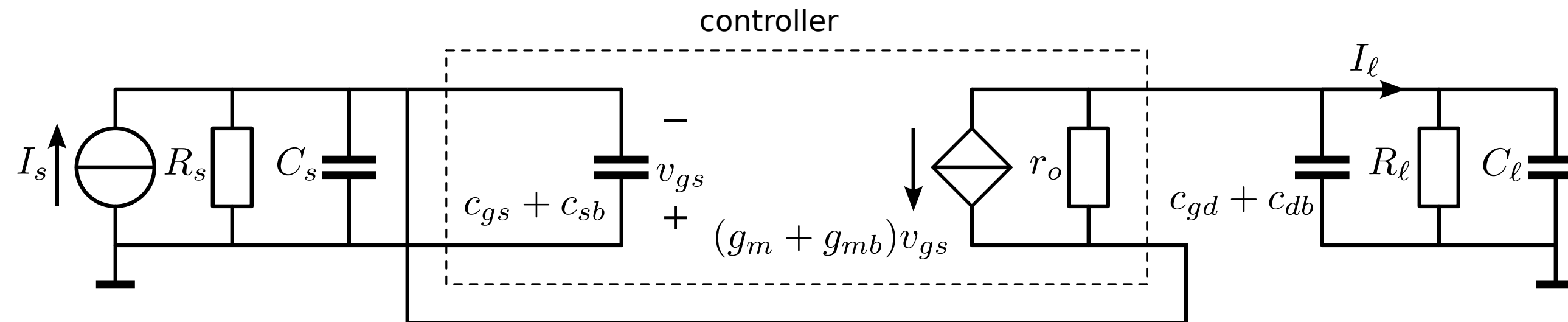


Simplified diagram:

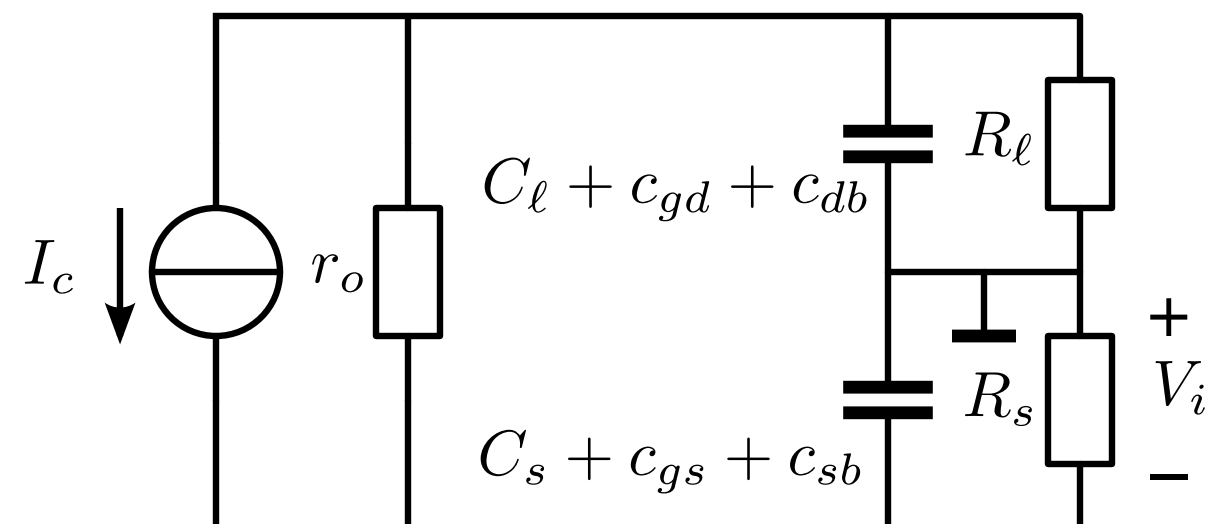


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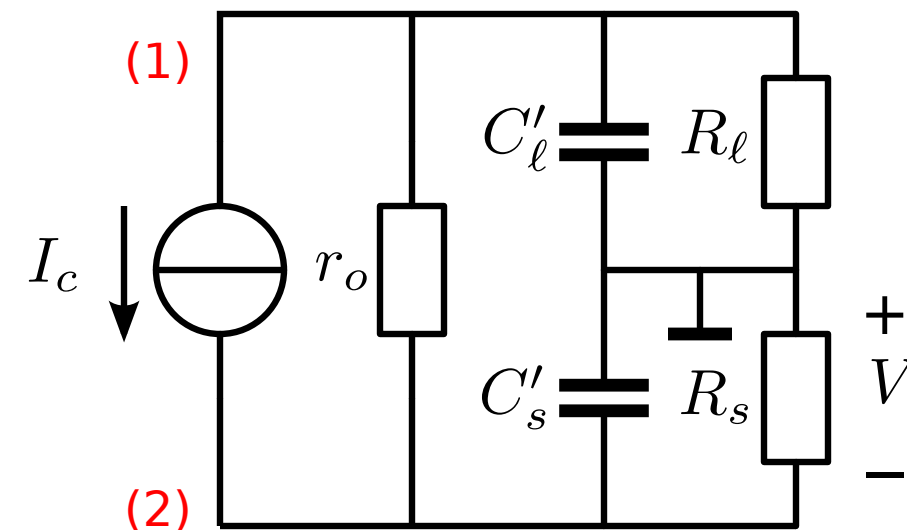


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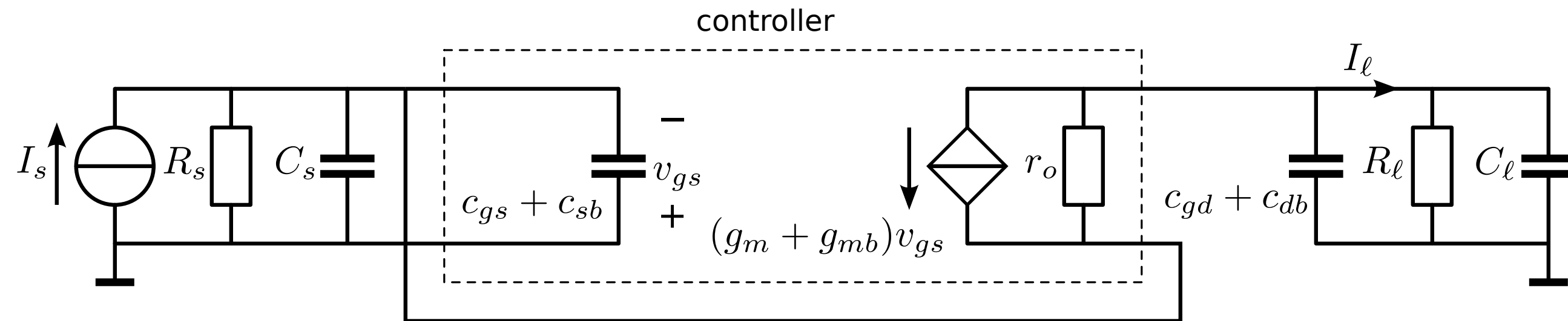
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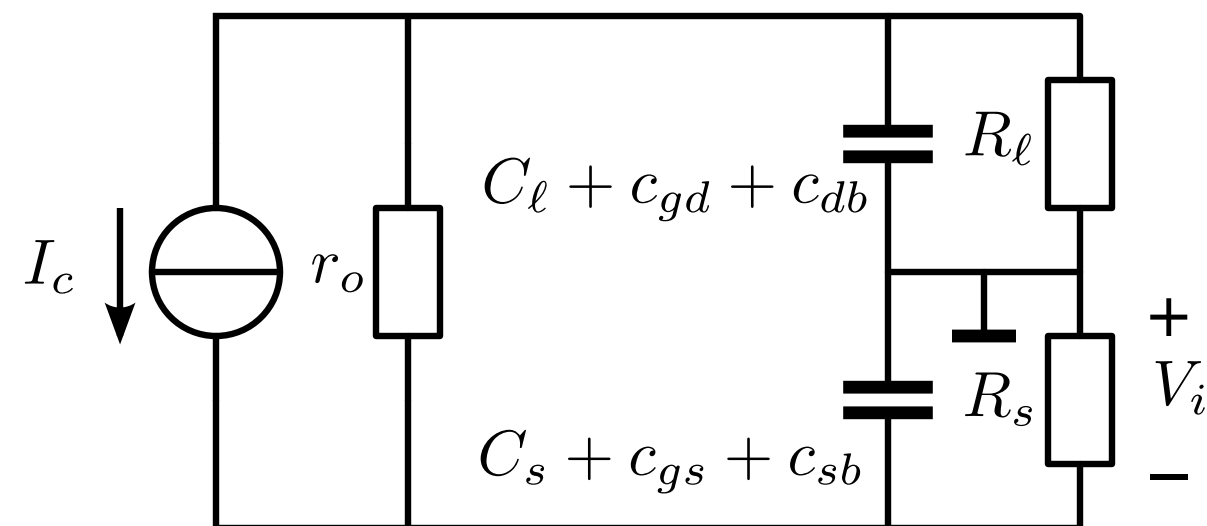


r_o establishes a direct transfer

CG stage loop gain

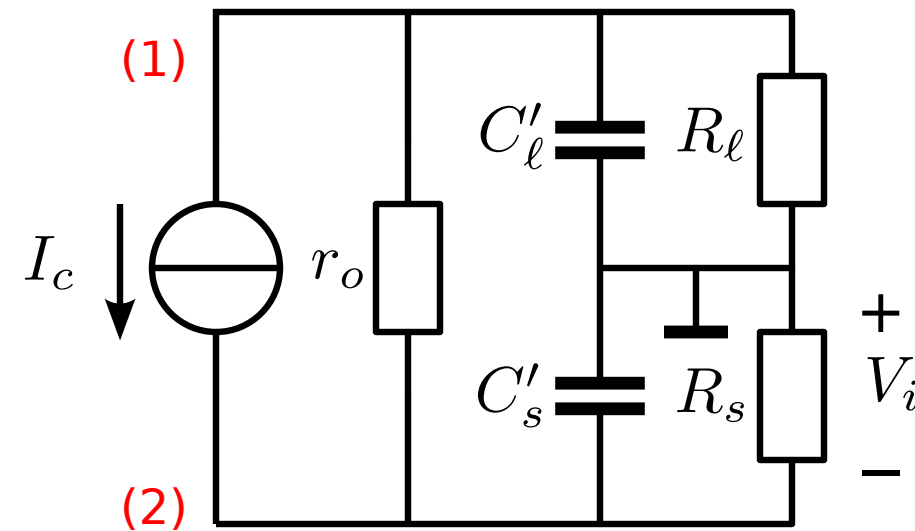


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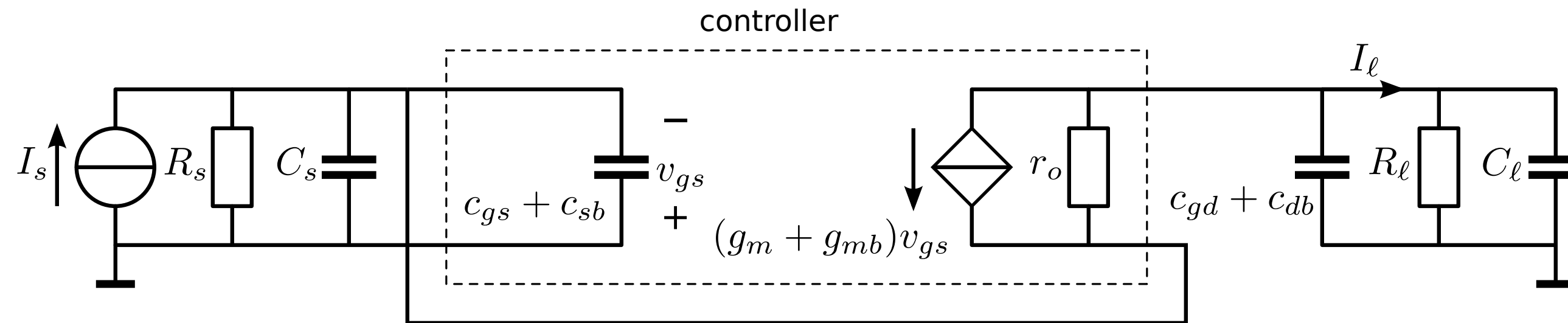
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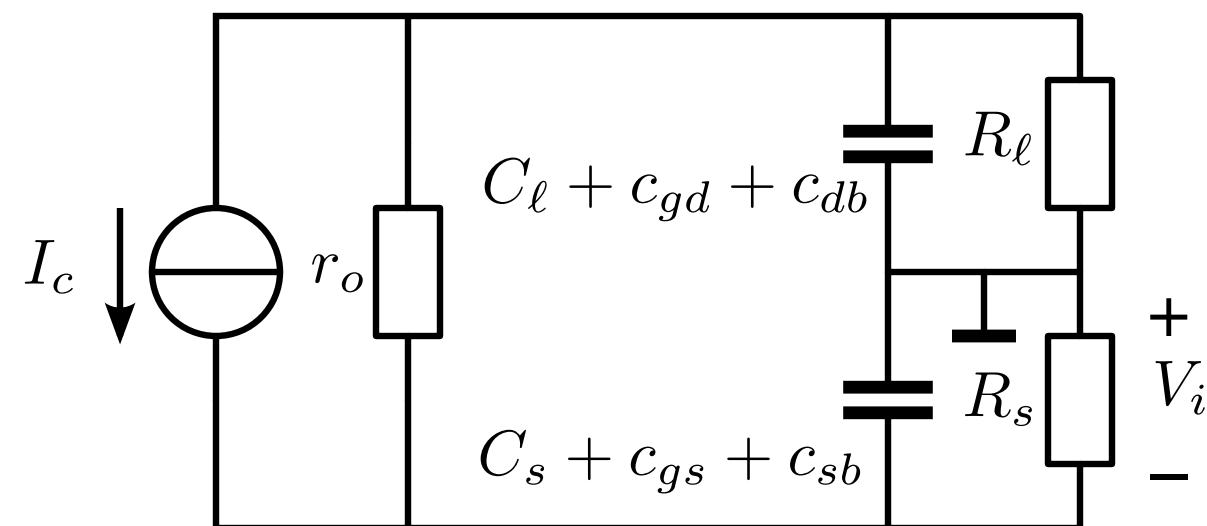
r_o establishes a direct transfer

Loop gain drops if:

CG stage loop gain

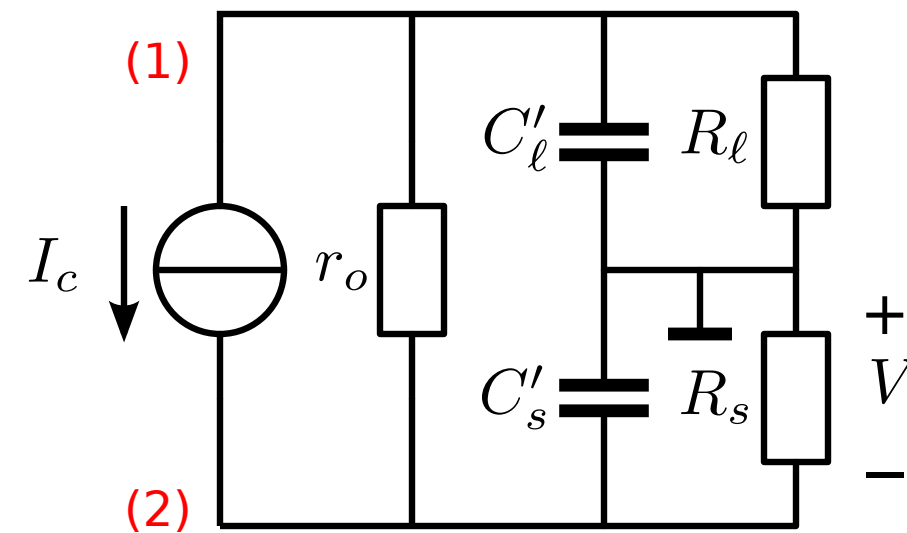


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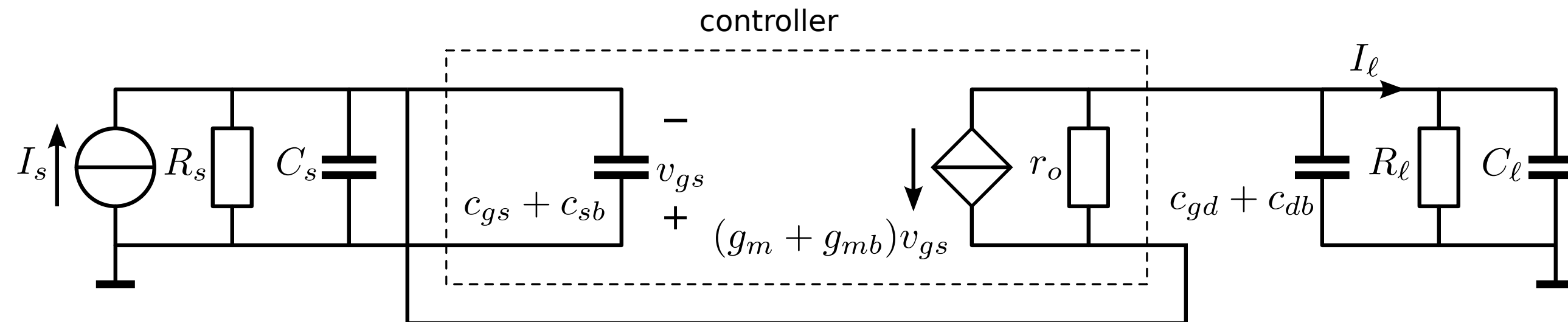


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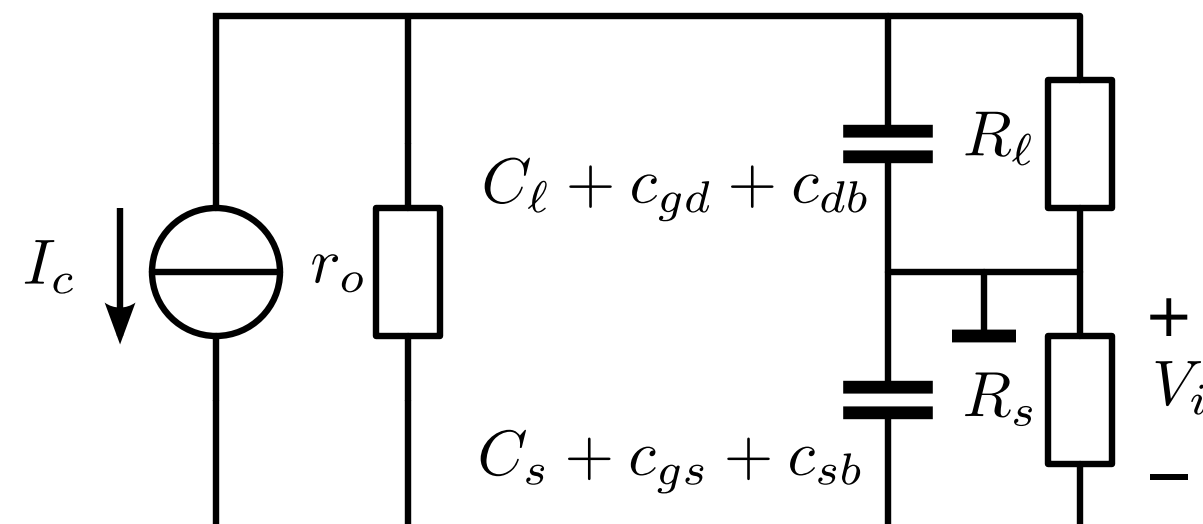
Loop gain drops if:

Load resistance increases

CG stage loop gain

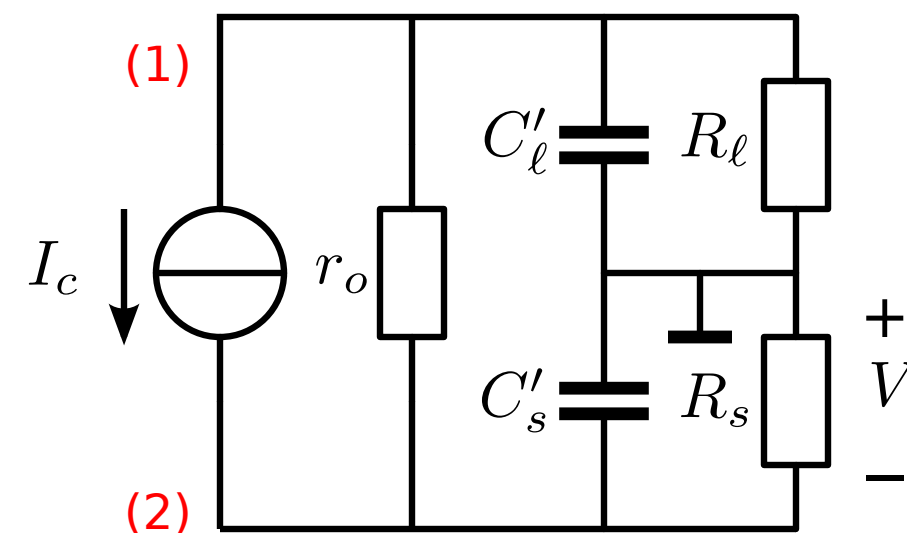


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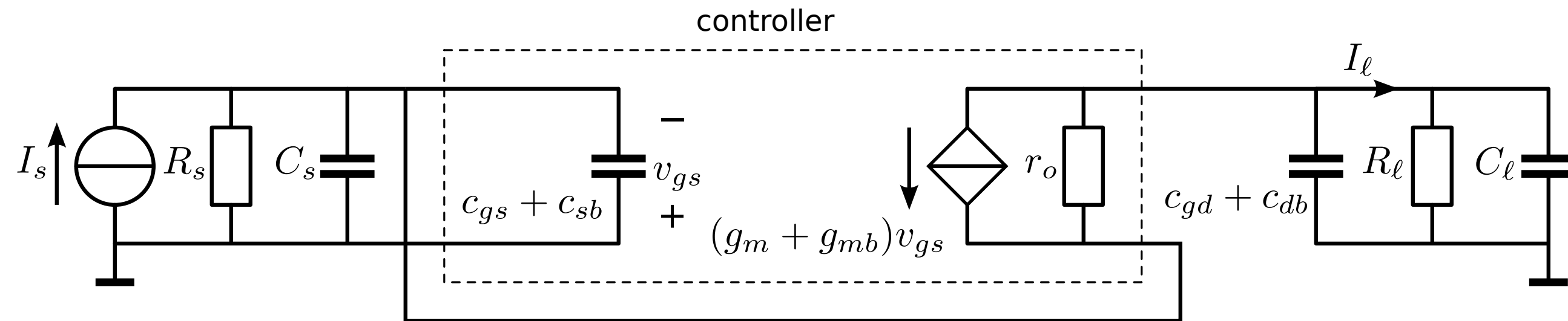
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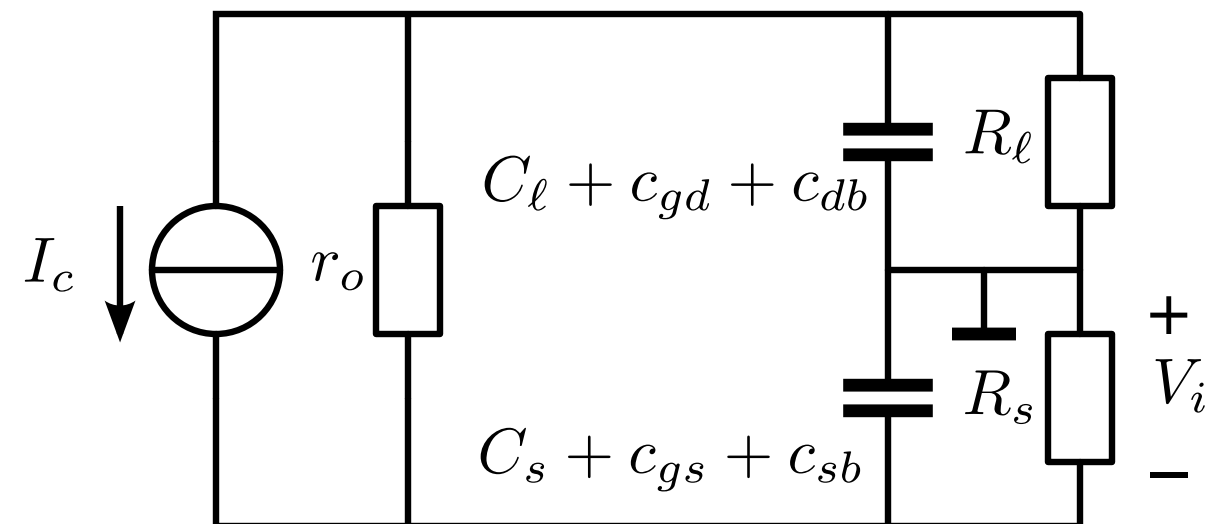
Load resistance increases

Load capacitance decreases

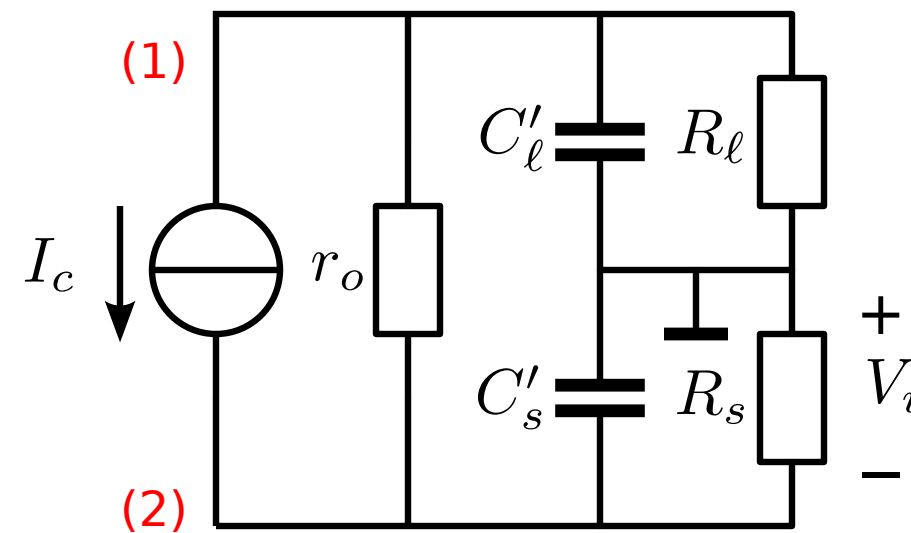
CG stage loop gain



Loop gain:



Simplified diagram:



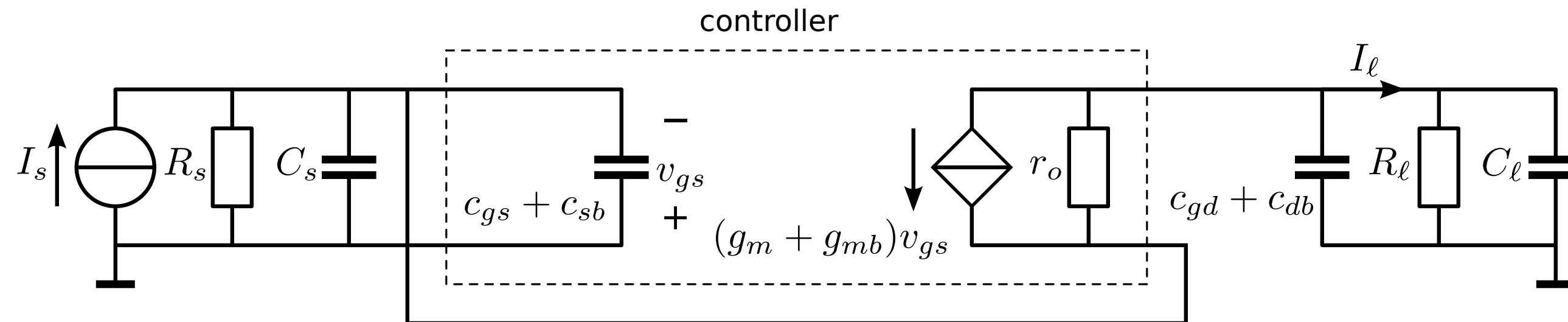
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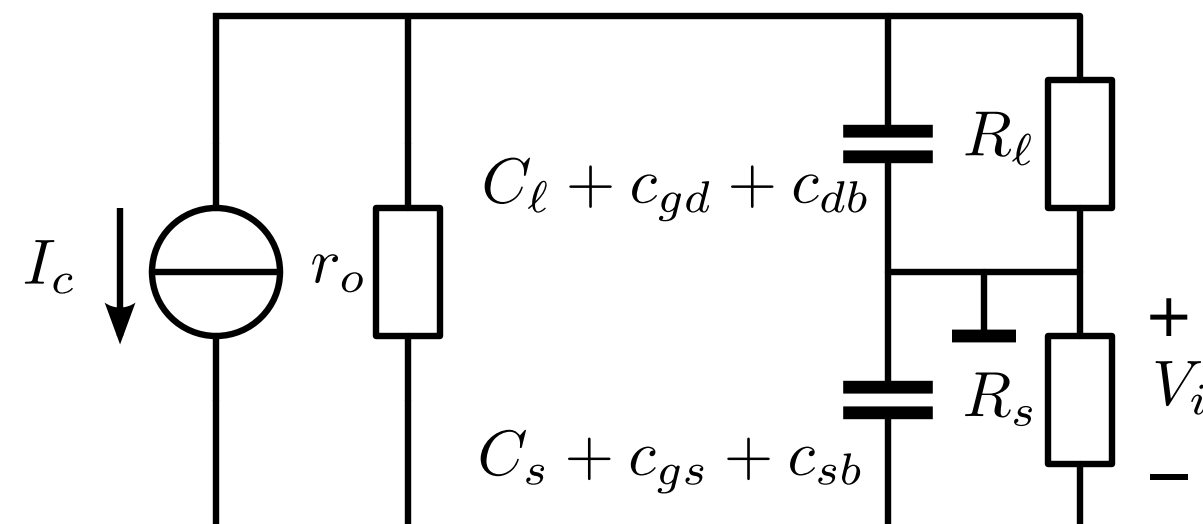
- Load resistance increases
- Load capacitance decreases
- Source resistance decreases

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CG stage loop gain

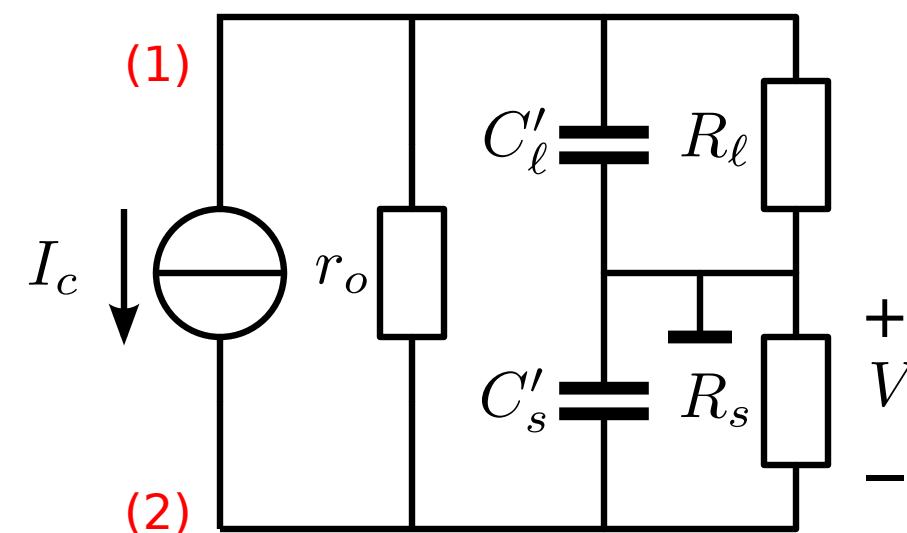


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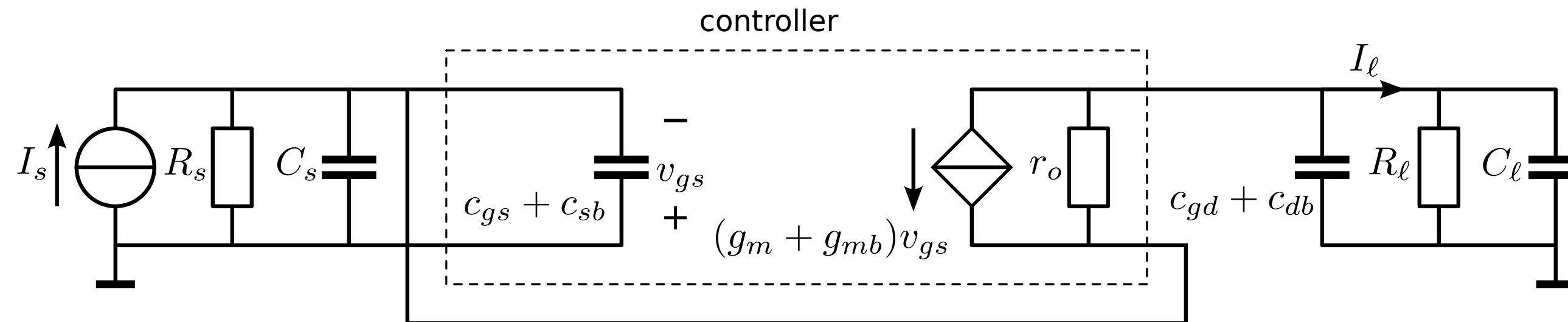


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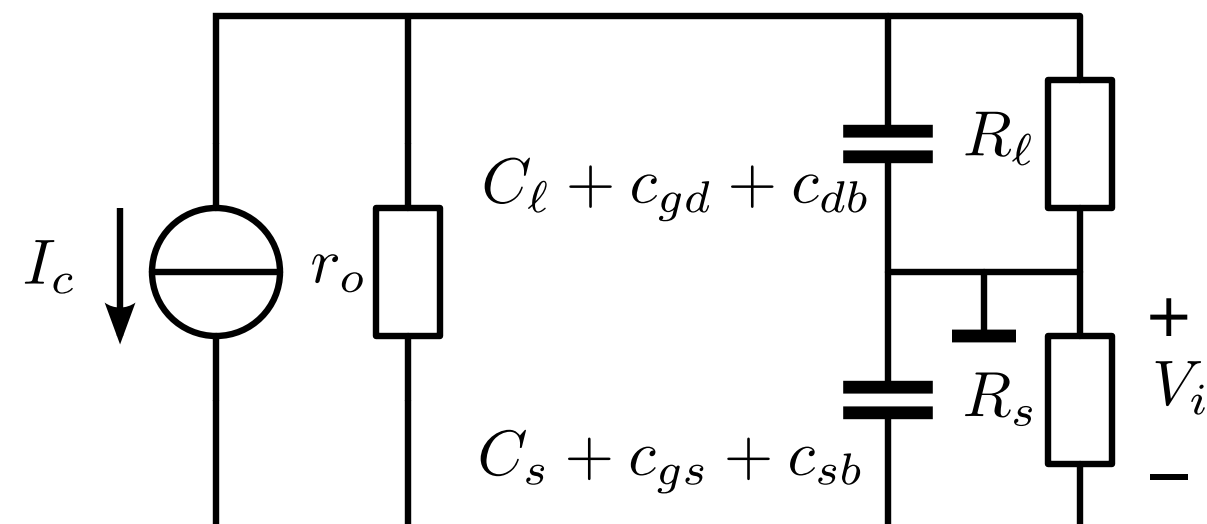
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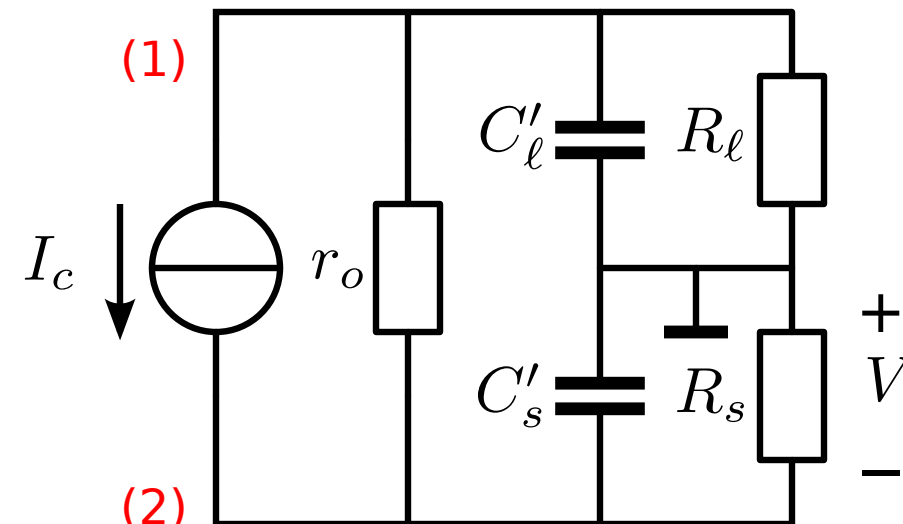
CG stage loop gain



Loop gain:



Simplified diagram:



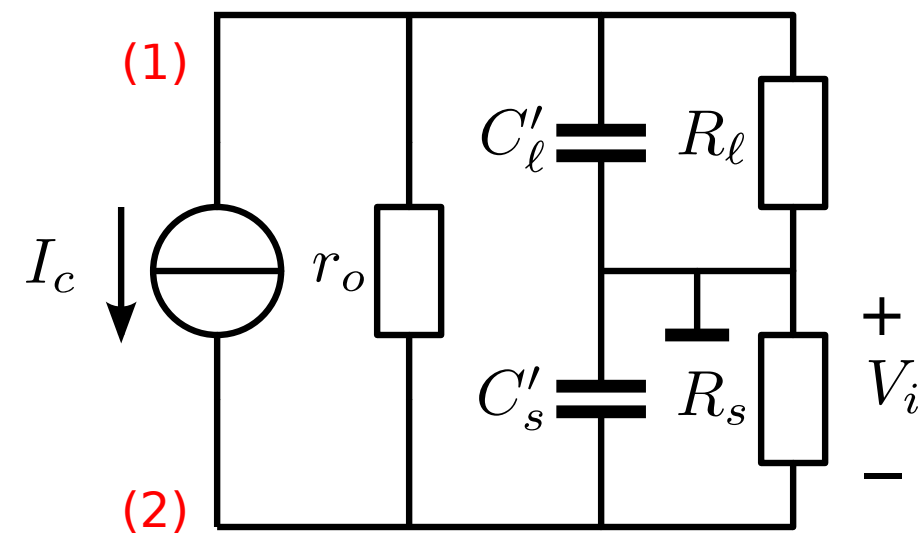
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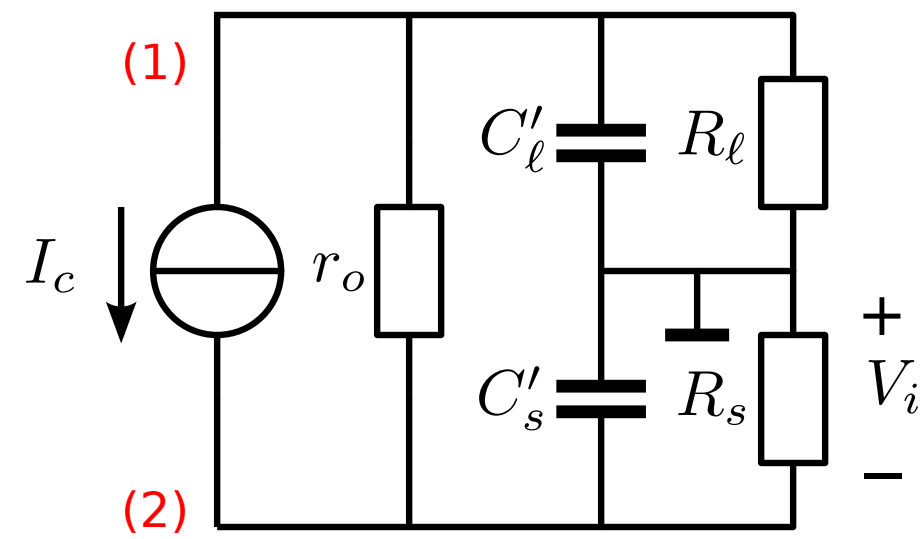
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CG stage bandwidth and stability

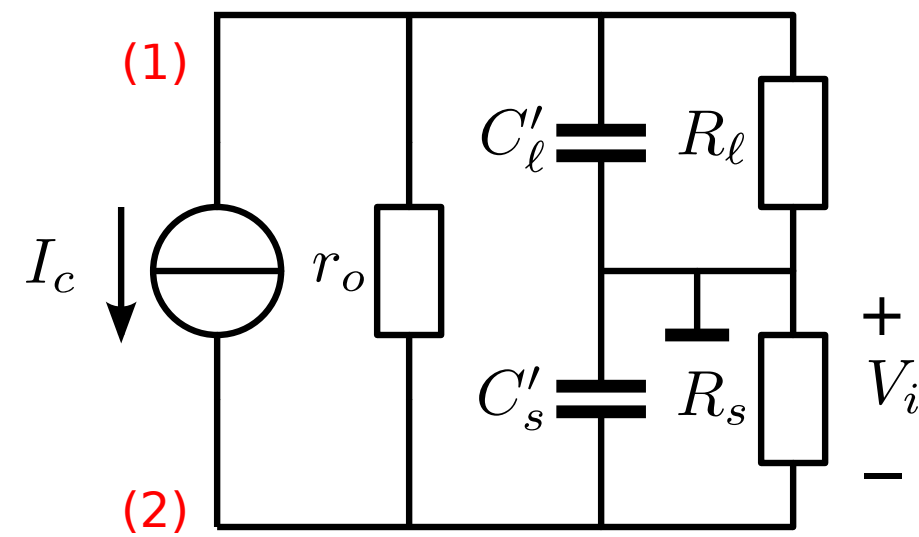


CG stage bandwidth and stability



$$L_{DC} = -\frac{R_s r_o (g_m + g_{mb})}{R_s + r_o + R_l}$$

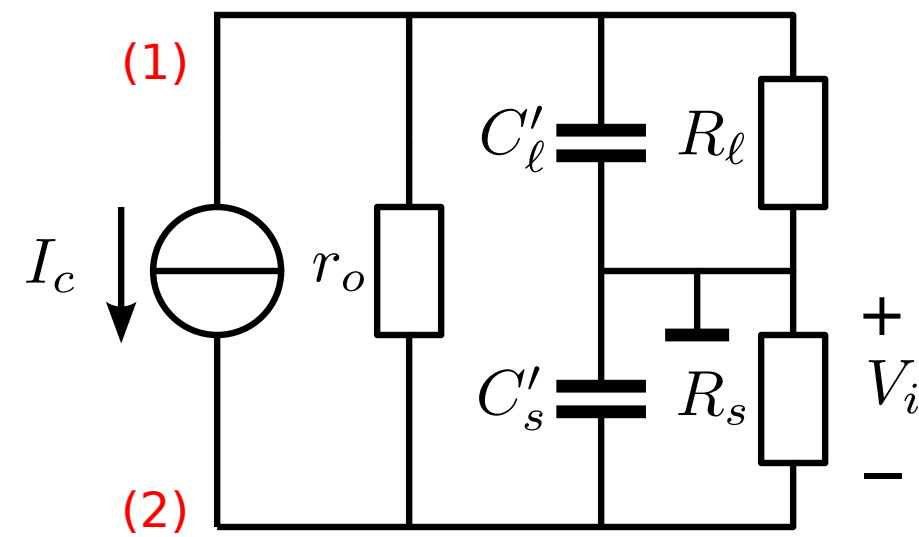
CG stage bandwidth and stability



$$L_{DC} = -\frac{R_s r_o (g_m + g_{mb})}{R_s + r_o + R_\ell}$$

$$L_{DC\max} = -n\mu$$

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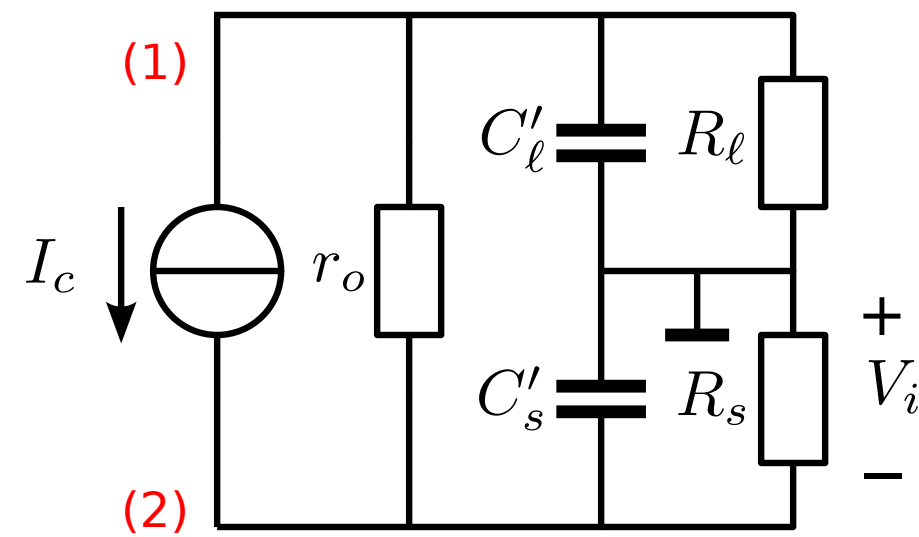


Two poles

$$L_{DC} = -\frac{R_s r_o (g_m + g_{mb})}{R_s + r_o + R_l}$$

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CG stage bandwidth and stability



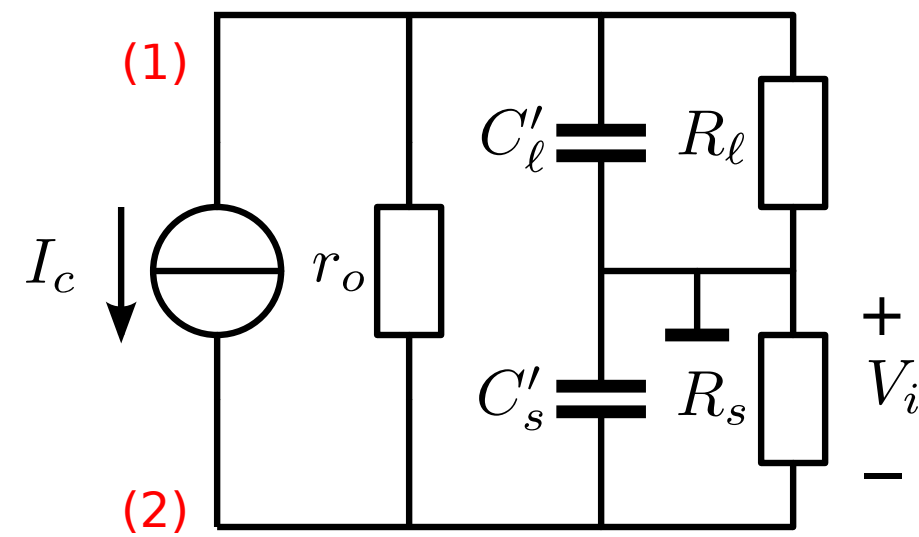
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One zero

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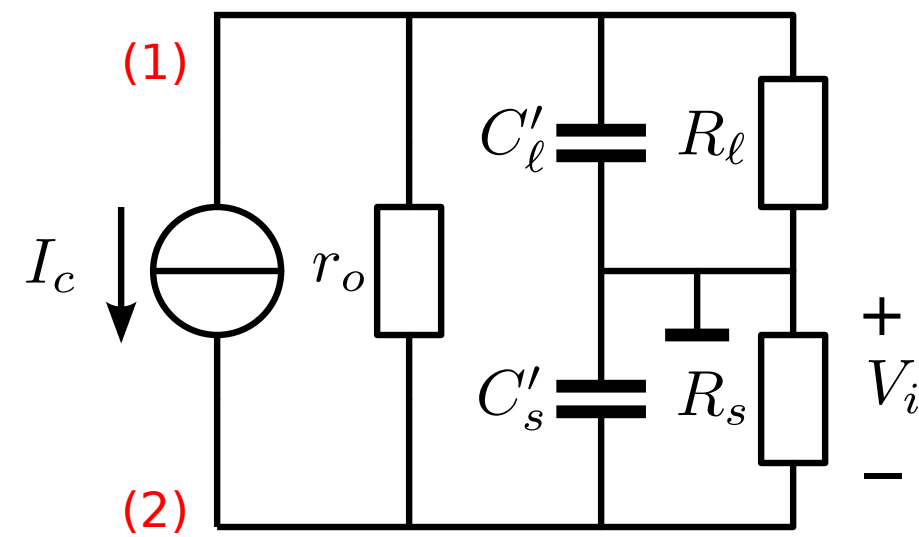
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Zero coincides with pole if: $R_\ell \ll r_o$

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CG stage bandwidth and stability



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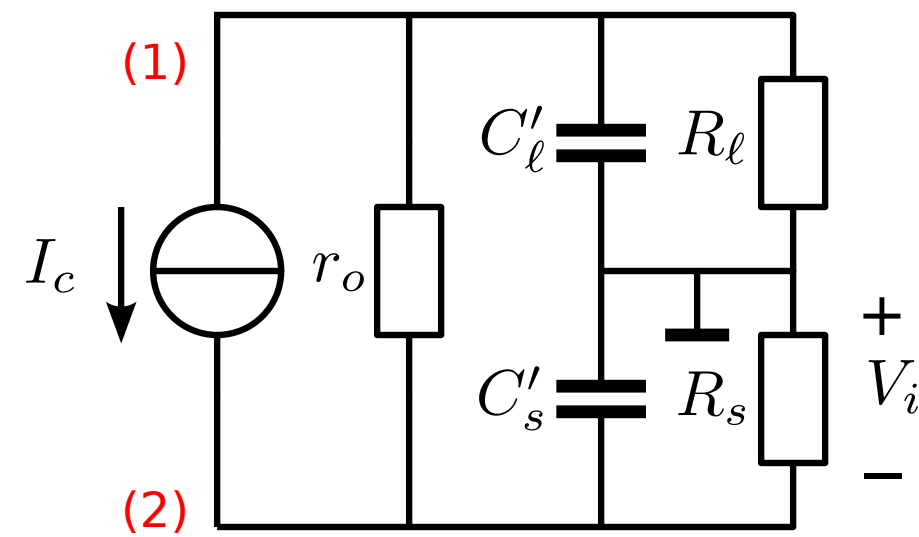
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Bandwidth: ω_T when driven from a relatively high impedance and terminated with a relatively low impedance

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