

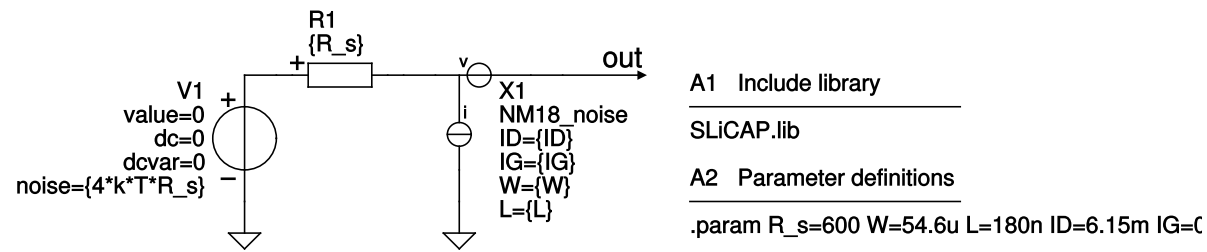
Structured Electronic Design

Intrinsic CS stage:
Stationary noise model

Anton J.M. Montagne

CS stage stationary noise behavior

Circuit Data



Study noise behavior for various source types

Find design parameters and show stopper values

Netlist: CS stage resistive noise

```

"CS stage resistive noise"
* gnetlist -q -g spice-noqsi -o CSresNoise.net CSresNoise.sch
* SPICE file generated by spice-noqsi version 20130710
* Send requests or bug reports to jpd@noqsi.com
.INCLUDE SLICAP.lib
X1 1 0 out NM18_noise ID={ID} W={W} L={L} IG={IG}
R1 2 1 {R_s}
V1 2 0 V value=0 dc=0 dcvar=0 noise={4*k*T*R_s}
.param R_s=600 W=54.6u L=180n ID=6.15m IG=0
.end
    
```

Operating parameters

Device width:

$$W = 5.46 \cdot 10^{-5} \quad (1)$$

Drain current for operation at critical inversion:

$$I_D = 0.006169 \quad (2)$$

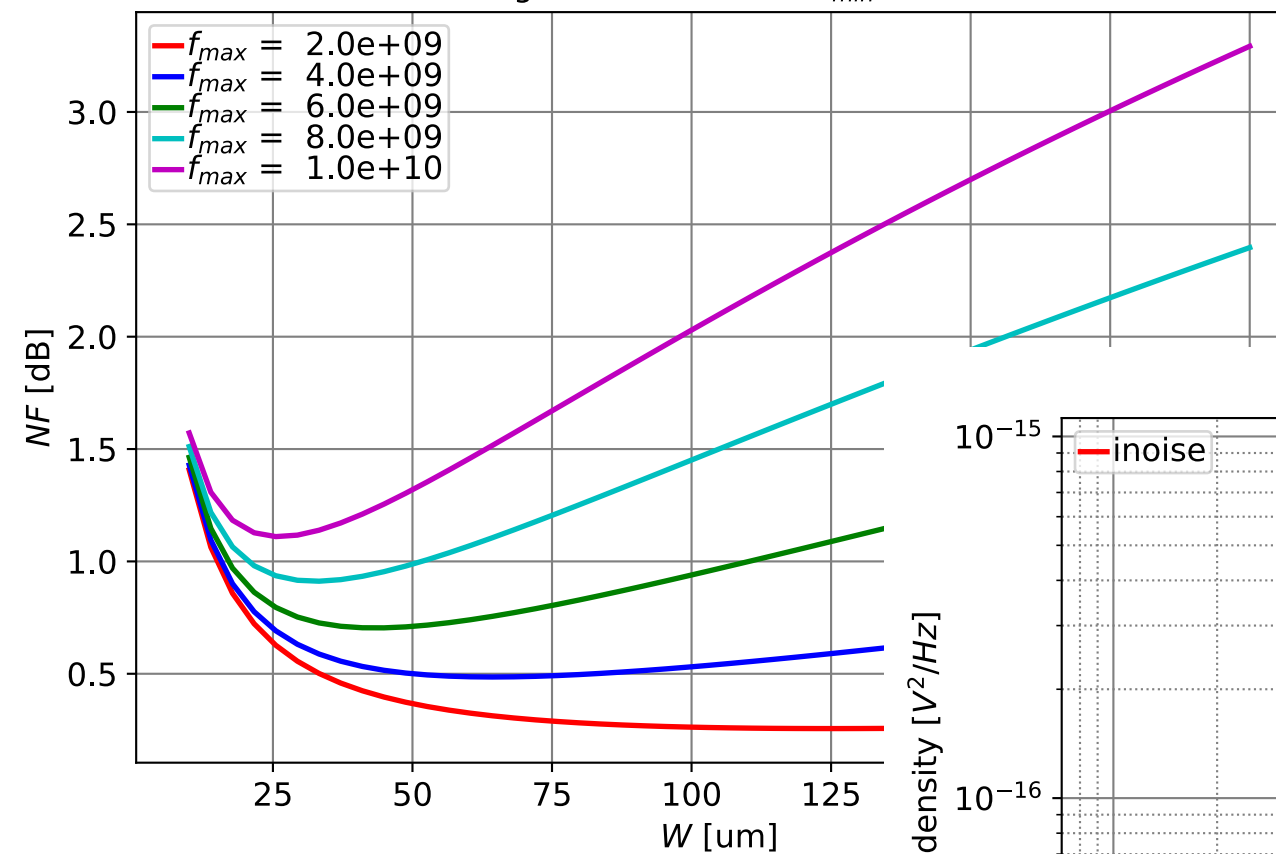
The effective noise resistance R_N equals:

$$R_N = 52.39 \quad (3)$$

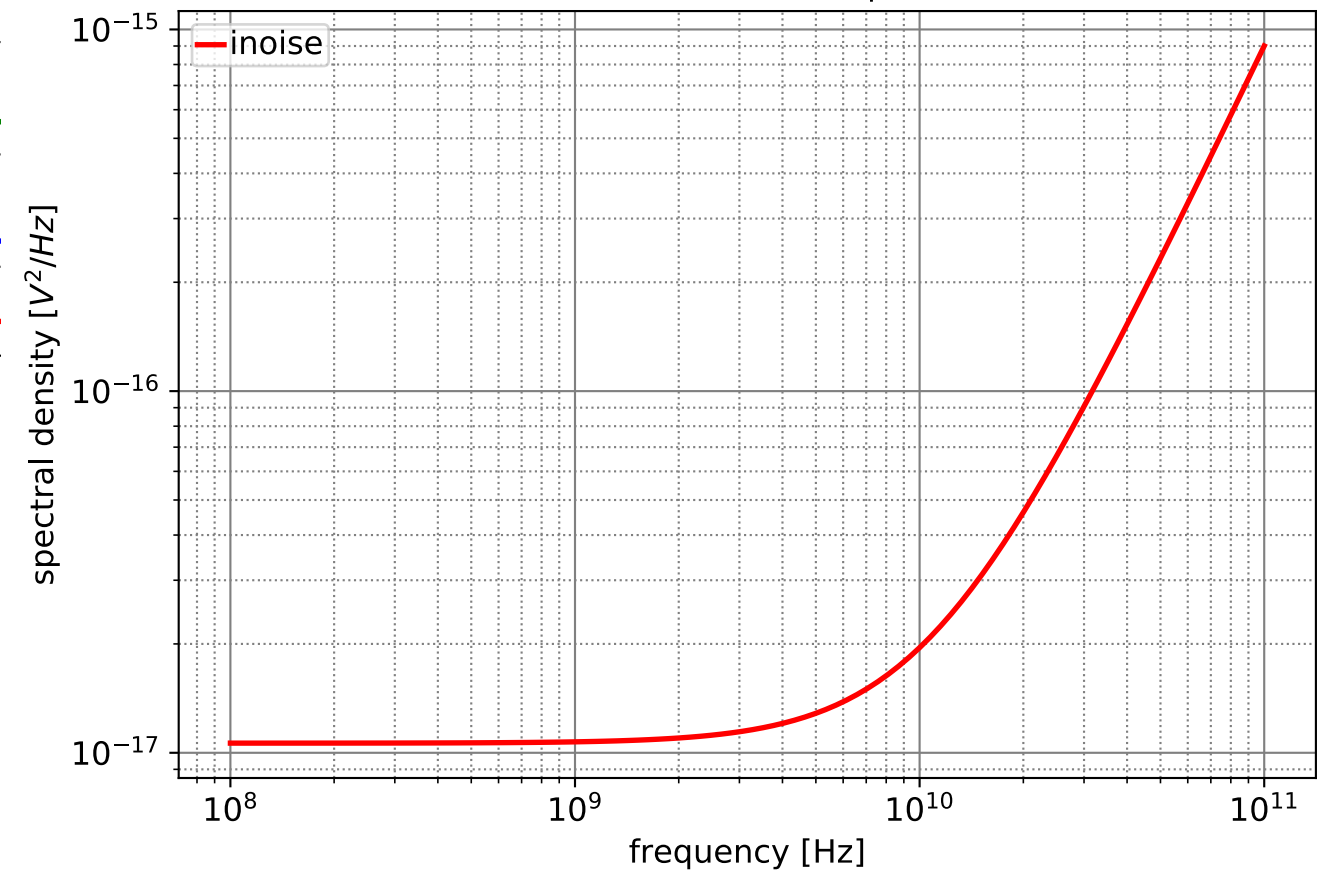
The cut-off frequency f_T equals:

$$f_T = 3.577 \cdot 10^{10} \quad (4)$$

Noise Figure versus width, $f_{min} = 200\text{MHz}$

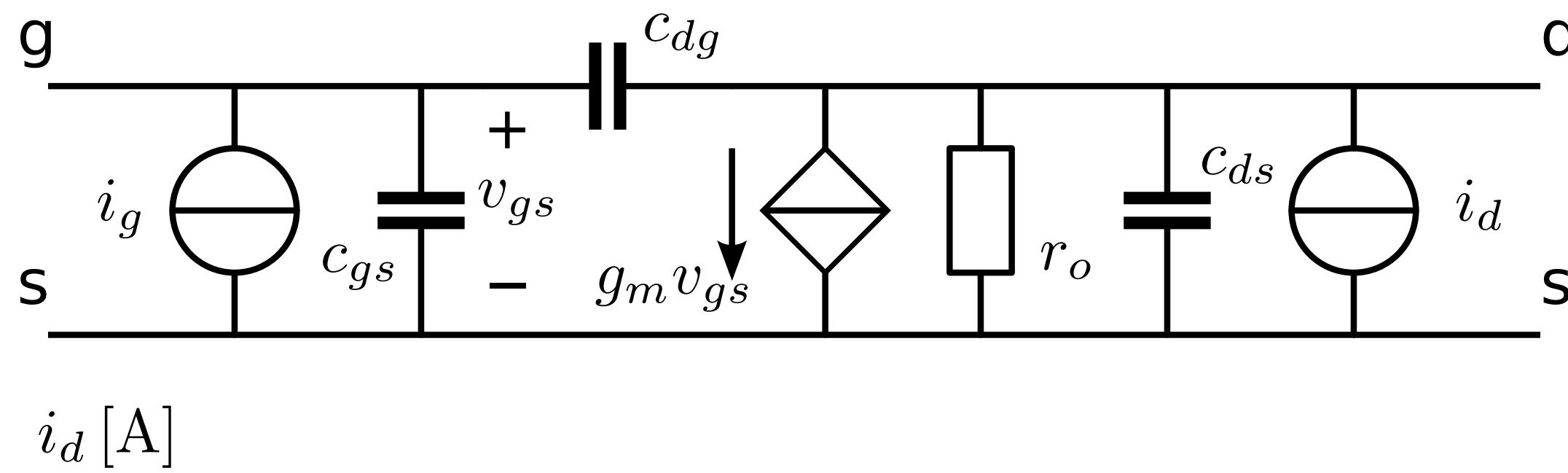


Source-referred noise spectrum

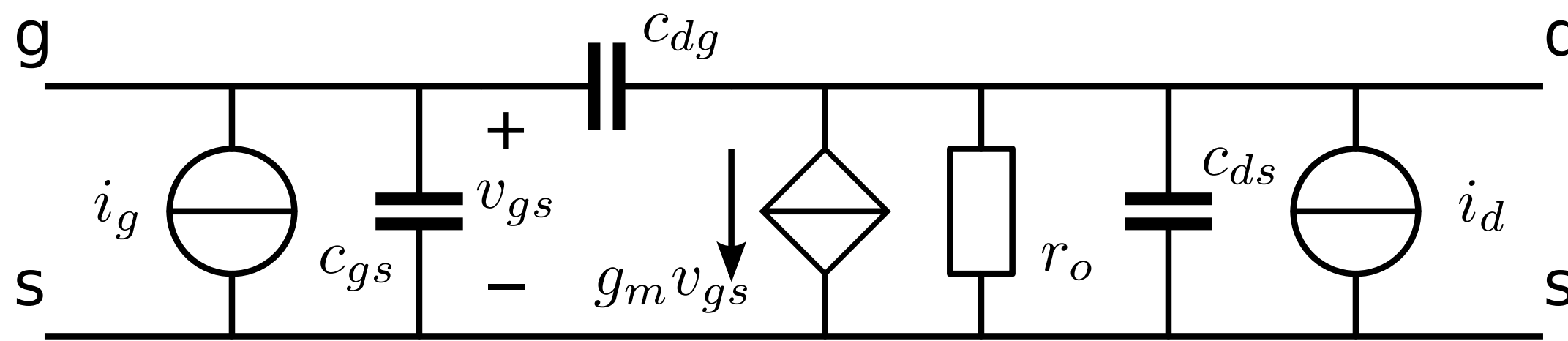


CS stage stationary model

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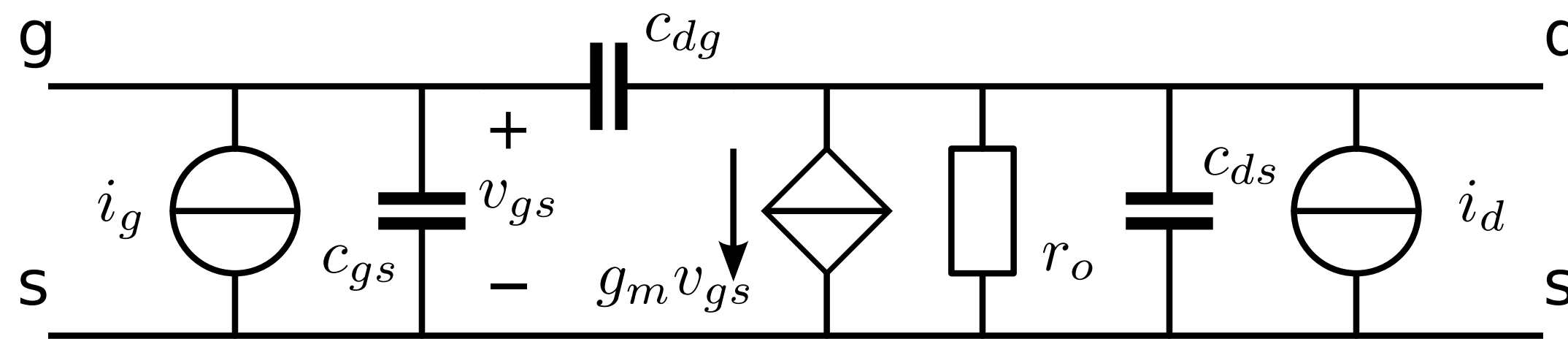


CS stage stationary model



i_d [A] noise current associated with the drain current

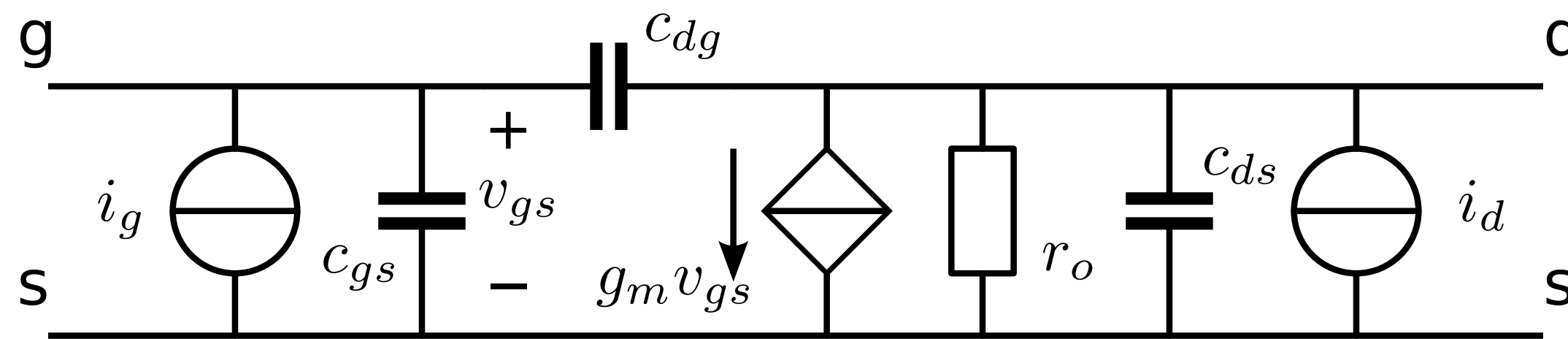
CS stage stationary model



i_d [A] noise current associated with the drain current

$$S_{i_d} = 4kTn\Gamma g_m \left(1 + \frac{f_l}{f} \right) [\text{A}^2\text{Hz}^{-1}]$$

CS stage stationary model

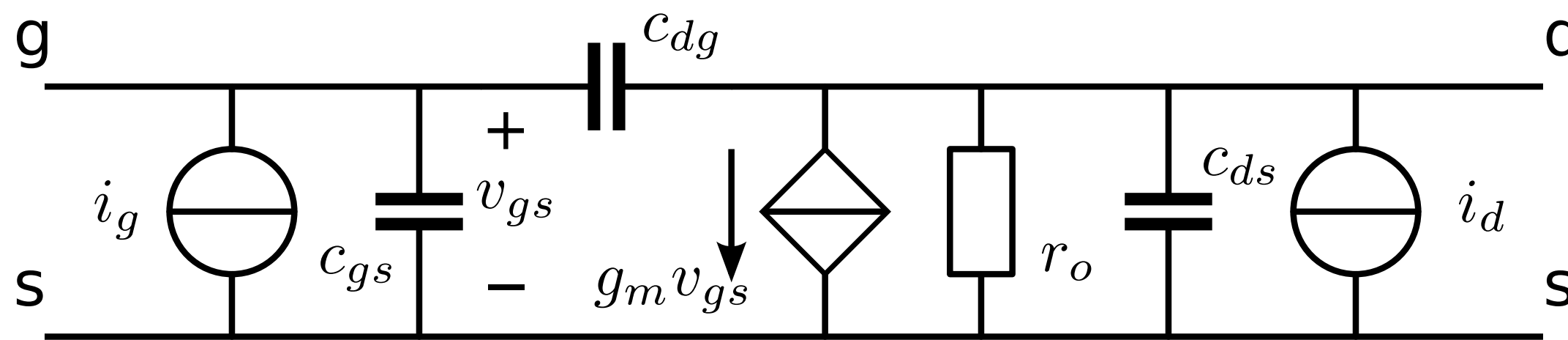


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$$\Gamma = \frac{1}{2} [-] \text{ in weak inversion}$$

CS stage stationary model



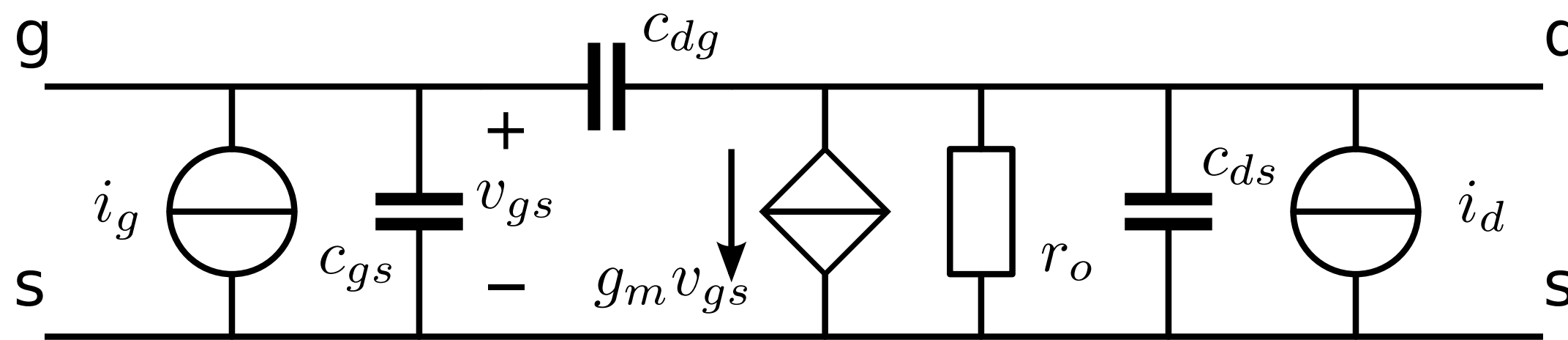
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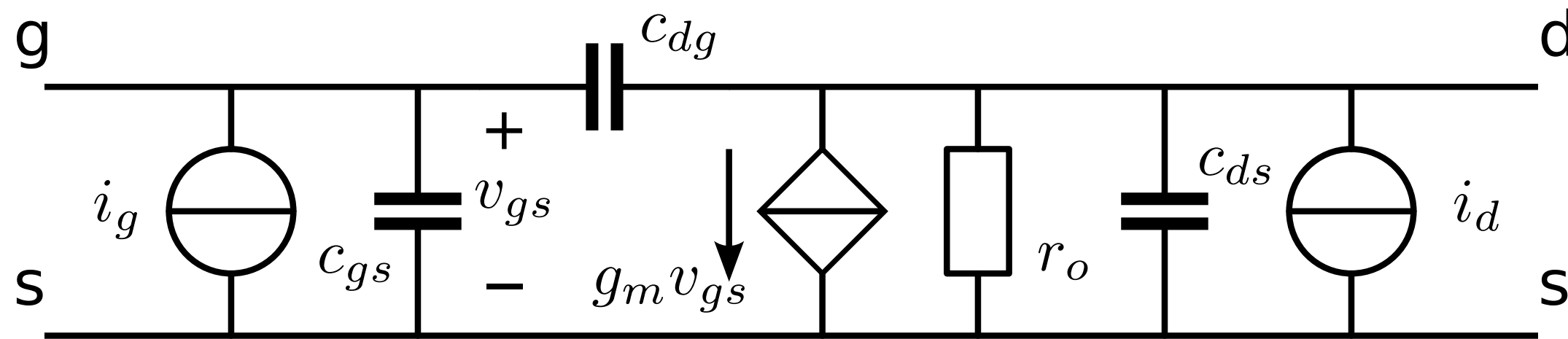
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$$\Gamma = \frac{\frac{1}{2} + \frac{2}{3}IC}{1+IC} [-]$$

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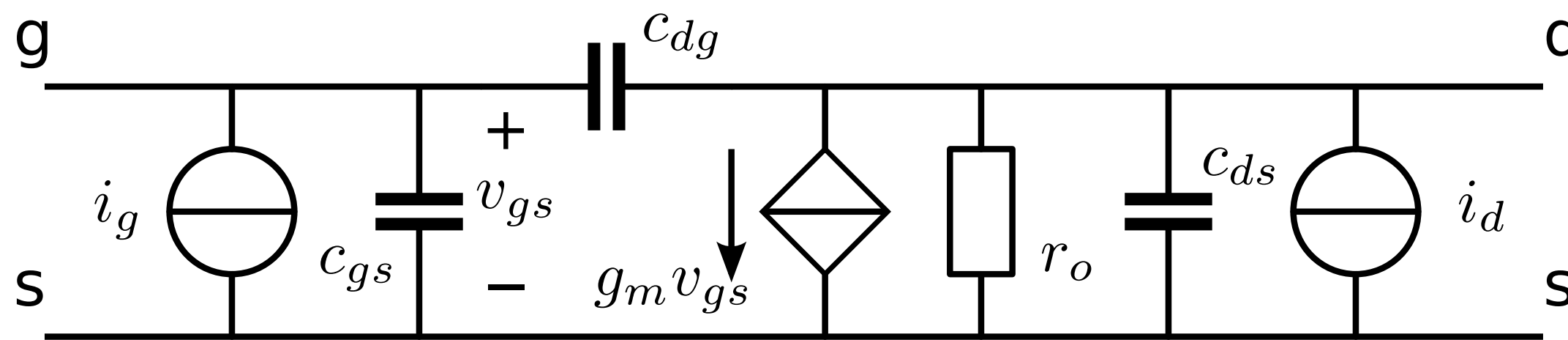
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$$f_\ell = \text{KF} \frac{3\pi}{4kTn\Gamma} f_T \text{ [Hz] corner frequency 1/f noise}$$

CS stage stationary model



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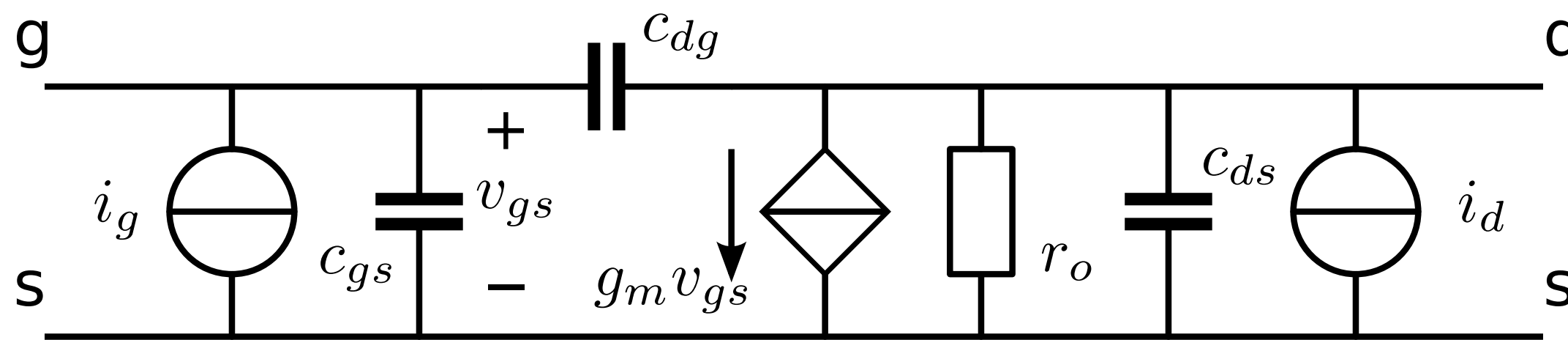
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KF [J] process parameter

CS stage stationary model



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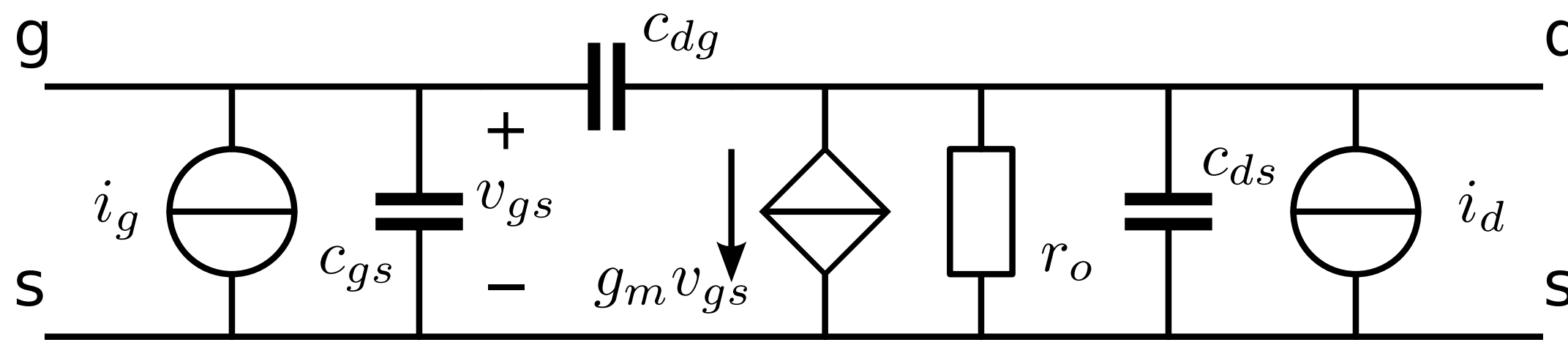
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$$f_\ell \propto f_T$$

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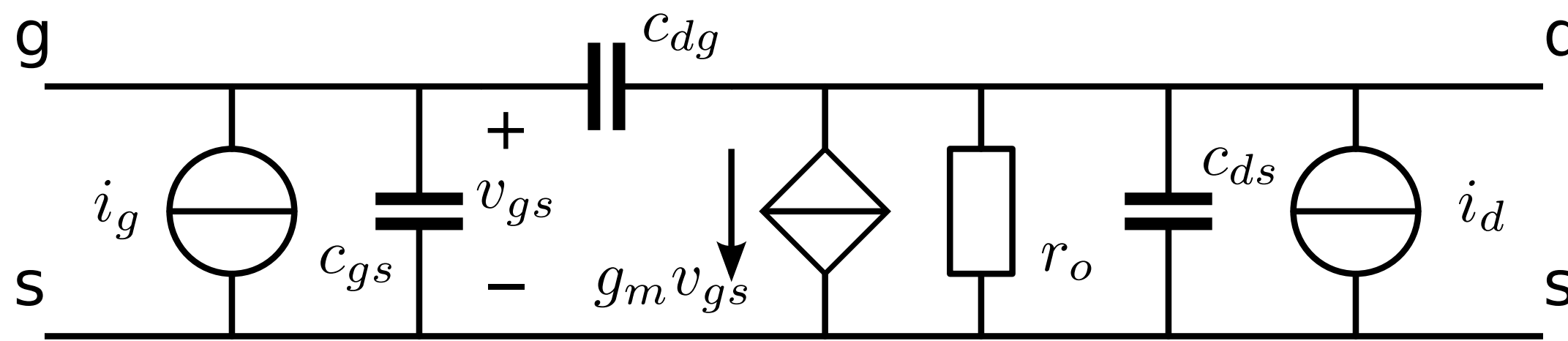
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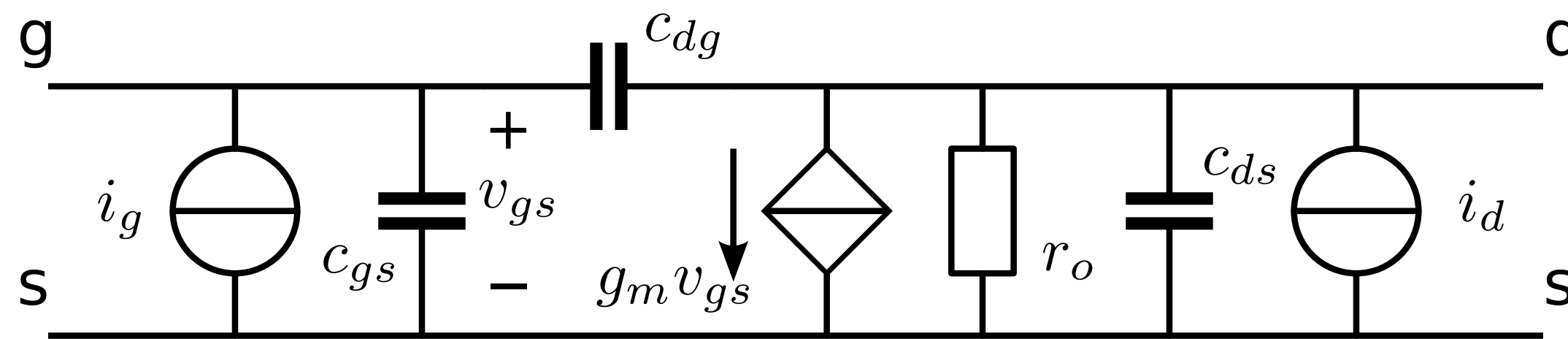
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CS stage stationary model



i_g [A] noise current associated with the gate current

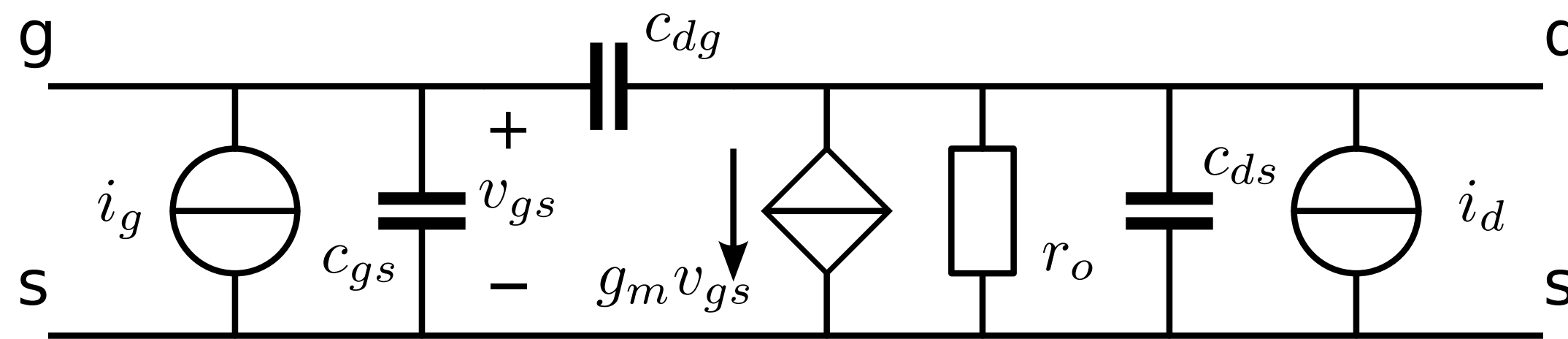
CS stage stationary model



i_g [A] noise current associated with the gate current

$$S_{i_g} = 2qI_G \left(1 + \frac{f_{lg}}{f} \right) [\text{A}^2\text{Hz}^{-1}]$$

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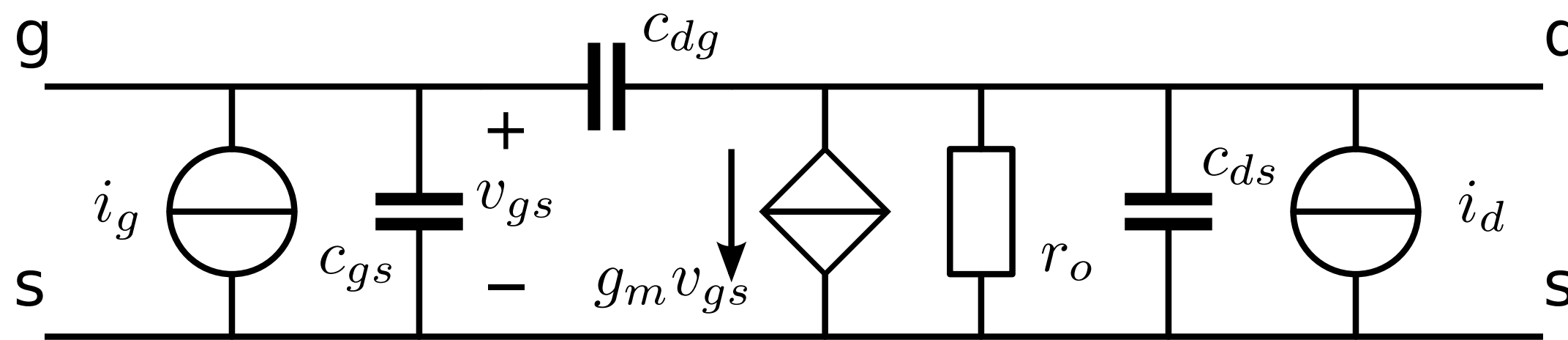


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I_G [A] DC gate current

CS stage stationary model



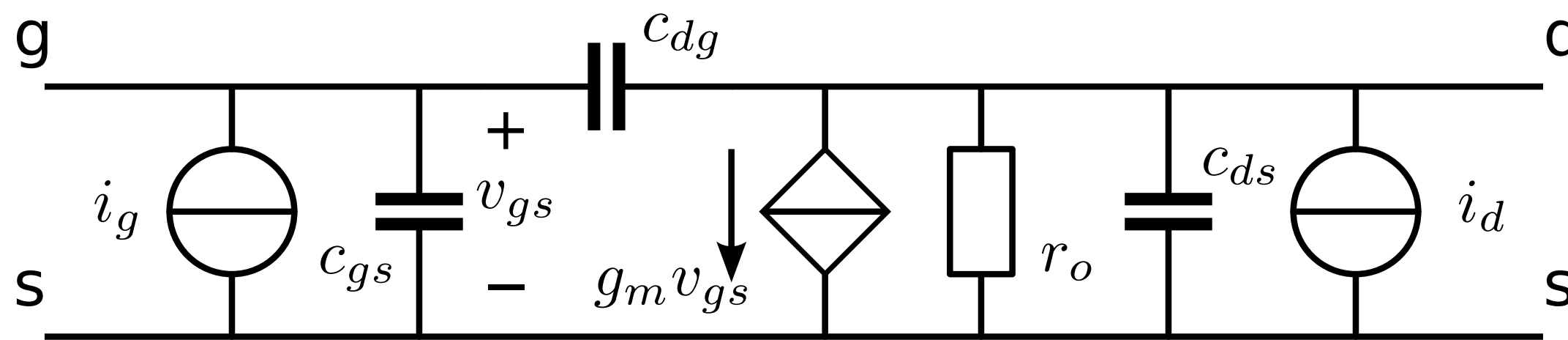
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f_{l_g} [Hz] corner frequency 1/f gate current noise

CS stage stationary model



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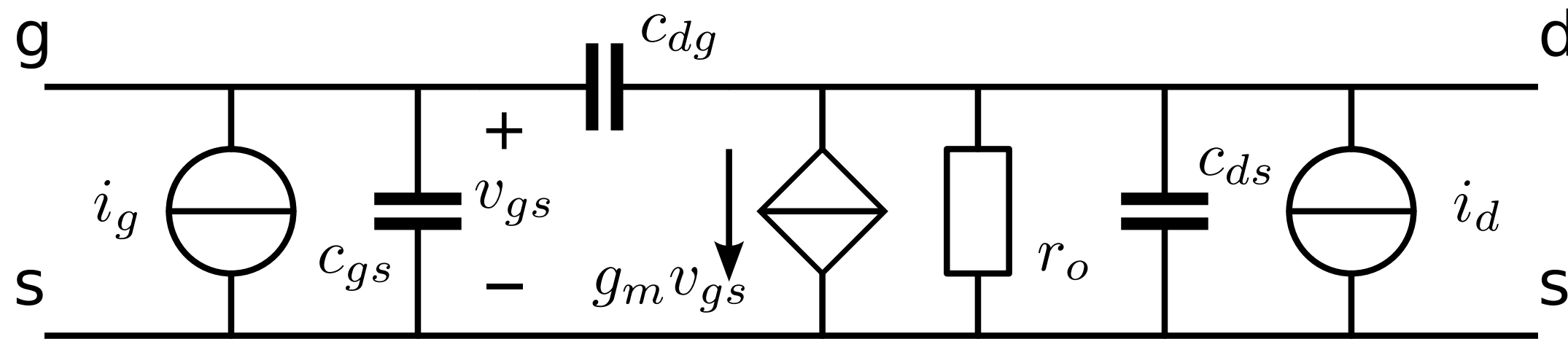
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