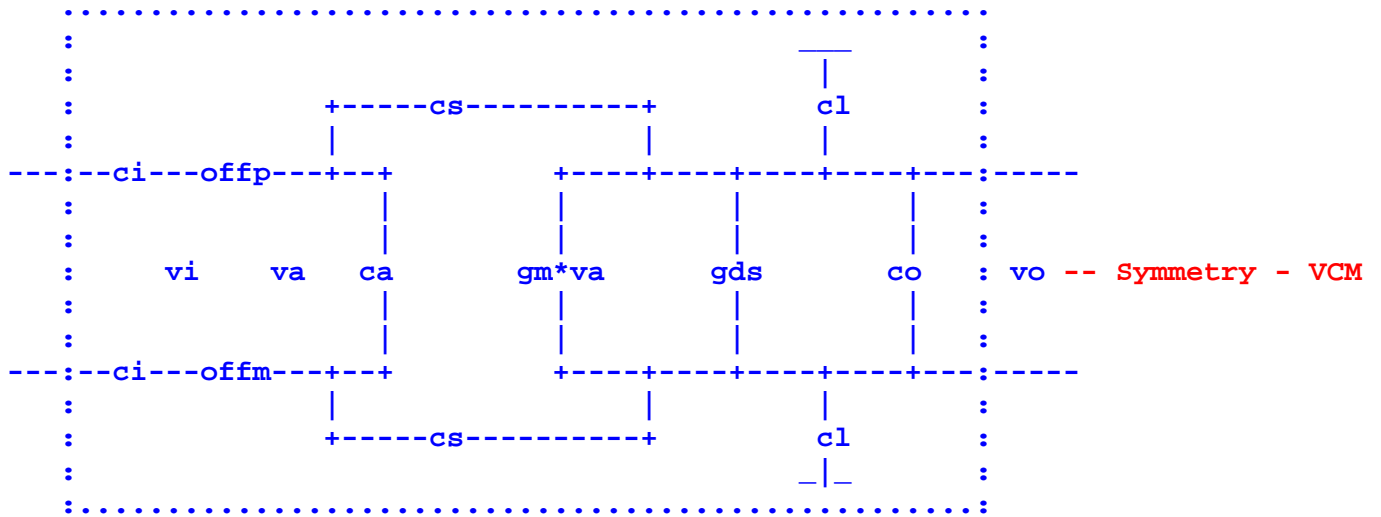


**NOTE on the Mapping
of Differential to Single-Ended
Architecture**

Yves Leduc

**** Differential Symmetrical Architecture



$$ceq = co + cl/2 + 1 / (2/cs + 1/ca + 2/ci)$$

$$dc_gain = gm / gds$$

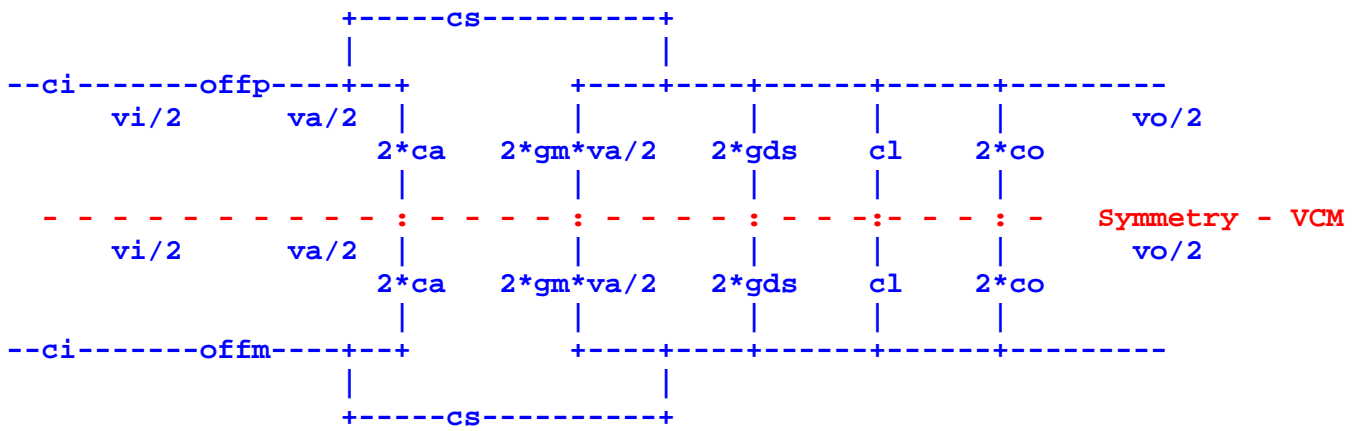
$$wt = \text{SQRT}(gm^2 - gds^2) / ceq$$

$$off = va - vi$$

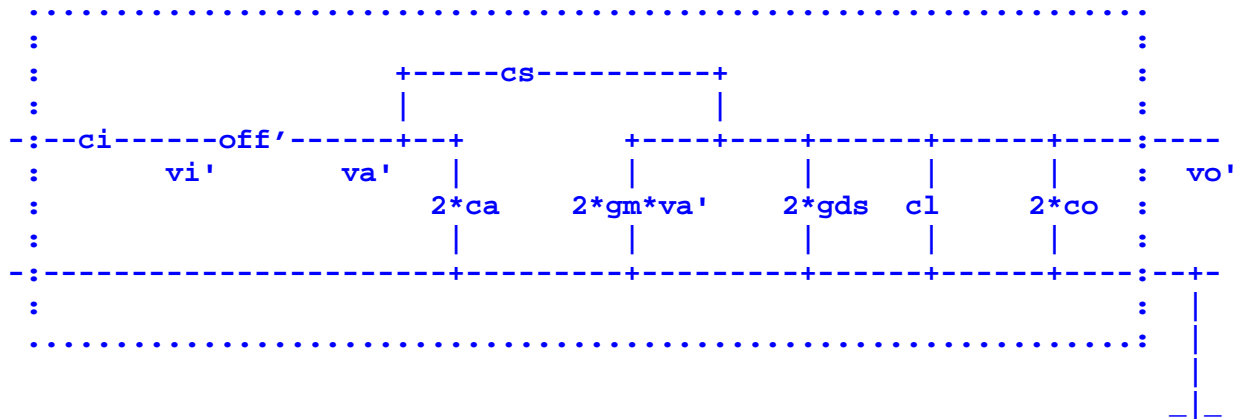
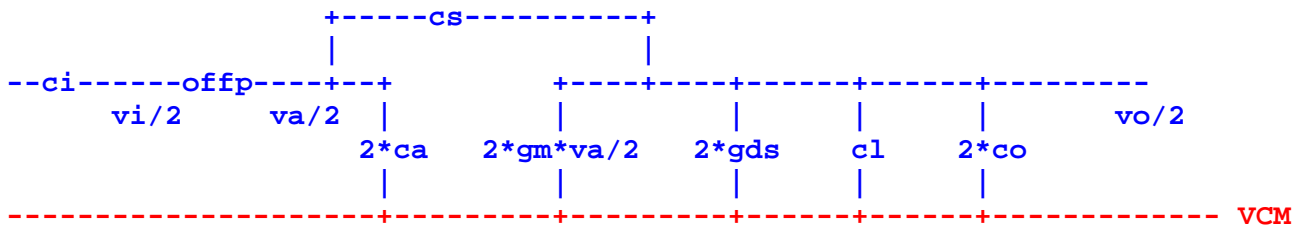
$$offp = off/2$$

$$offm = -off/2$$

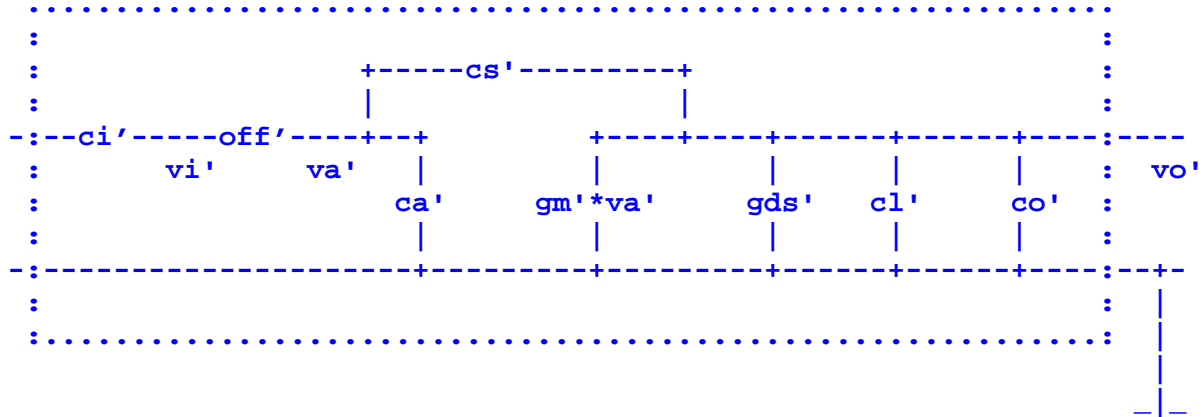
Differential Symmetrical Architecture (rewritten)



Taking upper part of the Differential Symmetrical Architecture



****** Single-Ended Architecture**



$vi' = vi$
 $va' = va$
 $vo' = vo$

WE DEFINE THE CORRESPONDENCE (MAPPING):

$off' = off$
 $ci' = ci$
 $ca' = 2*ca$
 $co' = 2*co$
 $cl' = cl$
 $cs' = cs$
 $gm' = 2*gm$
 $gds' = 2*gds$

WE DEDUCE:

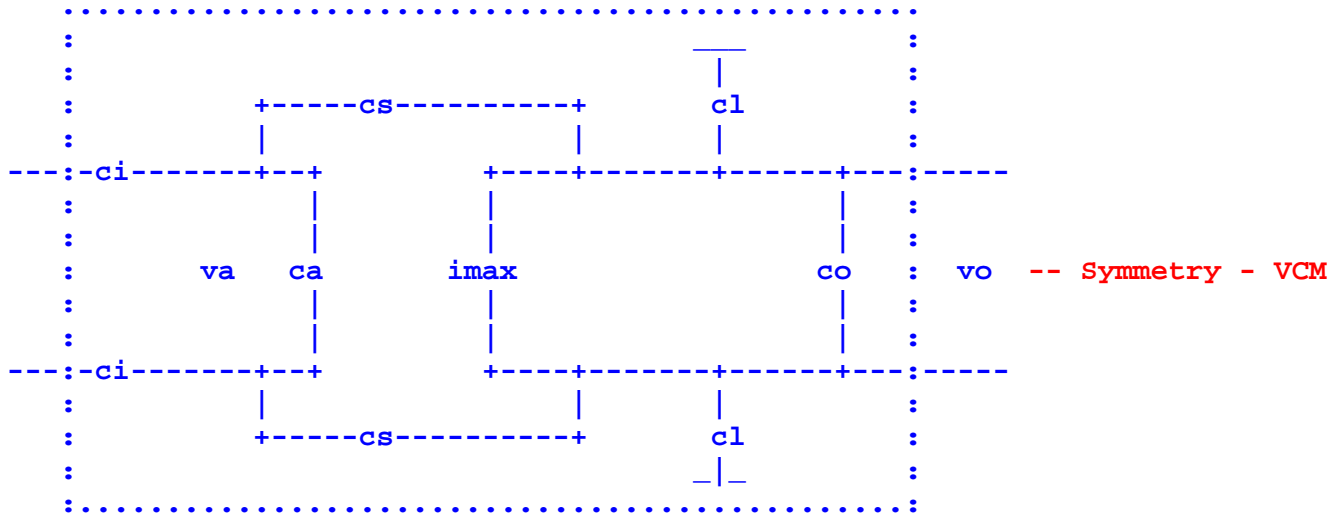
$$\begin{aligned} \text{ceq}' &= \text{co}' + \text{cl}' + 1 / (1/\text{cs}' + 1/\text{ca}' + 1/\text{ci}') \\ &= 2*\text{co} + \text{cl} + 1 / (1/\text{cs} + 1/(2*\text{ca}) + 1/\text{ci}) \\ &= 2*\text{co} + \text{cl} + 2 / (2/\text{cs} + 1/\text{ca} + 2/\text{ci}) \\ &= 2 * \text{ceq} \end{aligned}$$

$$\begin{aligned} \text{dc_gain}' &= \text{gm}' / \text{gds}' \\ &= (2*\text{gm}) / (2*\text{gds}) \\ &= \text{gm} / \text{gds} \\ &= \text{dc_gain} \end{aligned}$$

$$\begin{aligned} \text{wt}' &= \text{SQRT}(\text{gm}'^2 - \text{gds}'^2) / \text{ceq}' \\ &= \text{SQRT}(4*\text{gm}^2 - 4*\text{gds}^2) / (2*\text{ceq}) \\ &= \text{SQRT}(\text{gm}^2 - \text{gds}^2) / \text{ceq} \\ &= \text{wt} \end{aligned}$$

$$\begin{aligned} \text{off}' &= \text{va}' - \text{vi}' \\ &= \text{va} - \text{vi} \\ &= \text{offp} \\ &= \text{off}/2 \end{aligned}$$

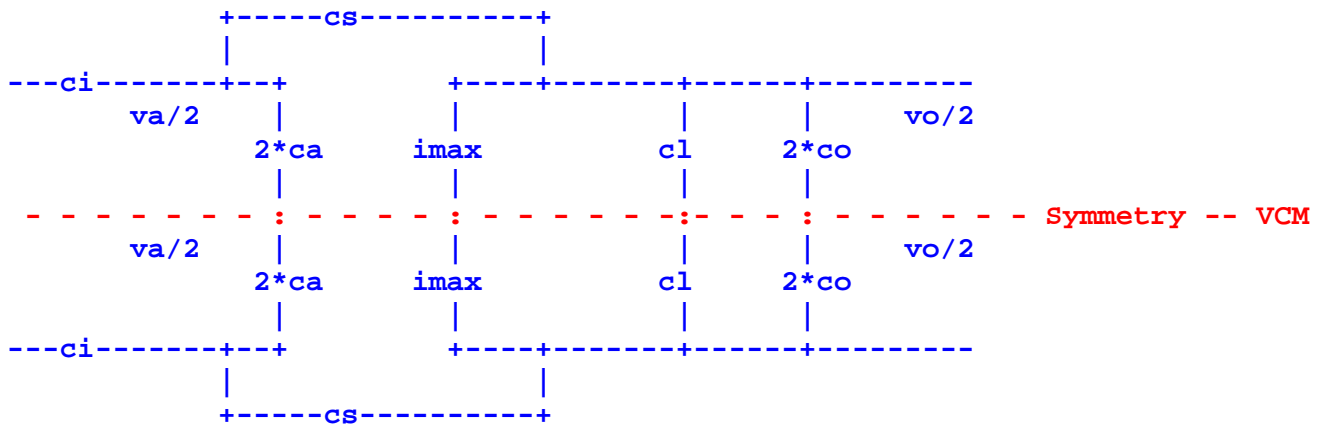
**** Differential Symmetrical Architecture



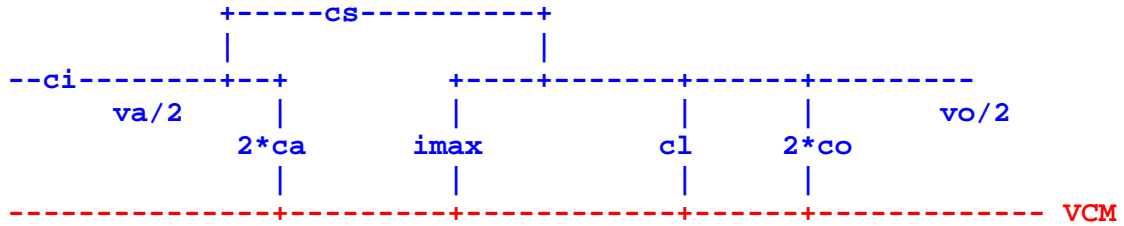
$$c_{eq} = c_o + c_l/2 + 1 / (2/c_s + 1/c_a + 2/c_i)$$

$$s_r = i_{max} / c_{eq}$$

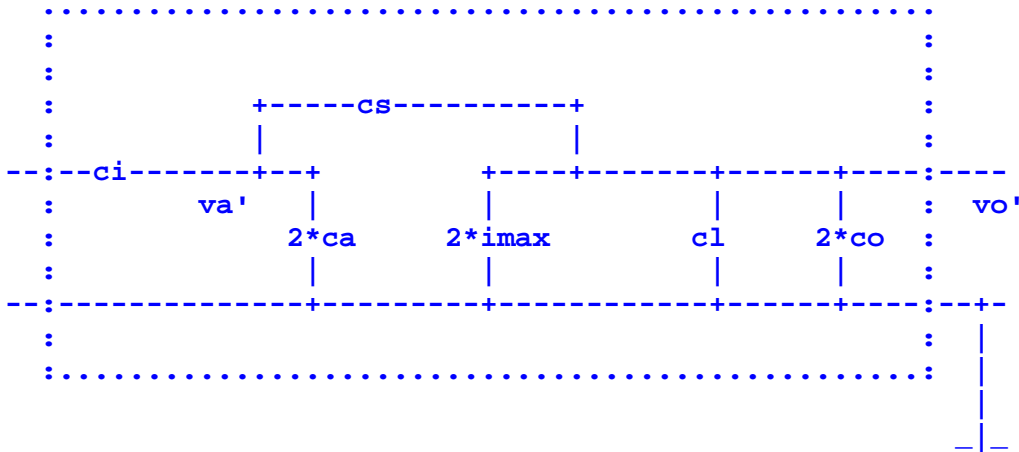
Differential Symmetrical Architecture (rewritten)



Taking upper part of the Differential Symmetrical Architecture



****** Single-Ended Architecture**



$$va' = va$$

$$vo' = vo$$

WE DEFINE THE CORRESPONDENCE (MAPPING):

$$ci' = ci$$

$$ca' = 2*ca$$

$$co' = 2*co$$

$$cl' = cl$$

$$cs' = cs$$

$$imax' = 2*imax$$

WE DEDUCE:

$$\begin{aligned} \text{ceq}' &= \text{co}' + \text{cl}' + 1 / (1/\text{cs}' + 1/\text{ca}' + 1/\text{ci}') \\ &= 2*\text{co} + \text{cl} + 1 / (1/\text{cs} + 1/(2*\text{ca}) + 1/\text{ci}) \\ &= 2*\text{co} + \text{cl} + 2 / (2/\text{cs} + 1/\text{ca} + 2/\text{ci}) \\ &= 2 * \text{ceq} \end{aligned}$$

$$\begin{aligned} \text{sr}' &= \text{imax}' / \text{ceq}' \\ &= 2*\text{imax} / (2*\text{ceq}) \\ &= \text{imax} / \text{ceq} \\ &= \text{sr} \end{aligned}$$

SUMMARY: MAPPING

SE <-----> DIFF

- vi' = vi
- va' = va
- vo' = vo

- off' = off

- ci' = ci
- ca' = 2*ca ←
- co' = 2*co ←
- cl' = cl
- cs' = cs
- gm' = 2*gm ←
- gds' = 2*gds ←

- imax' = 2*imax ←

THIS MAPPING GUARANTEES THAT

SE <-----> DIFF

- dc_gain' = dc_gain
- wt' = wt
- sr' = sr