ELE-plan for i dag

Forstærker med negativ feedback

- *Systematisere fejl - i forhold til ideel performance*

Modkoblet forstærker

- *Princip med α og β*
- *A_{OL}'s indflydelse på lukketsløjfeforstærkningen A_{CL}*
- *Fejlfaktor K_f*

Pause

Effekt af negativ feedback på Z_o, Z_{in} og A_{CL}

- *Ikke-inverterende kobling som eksempel*

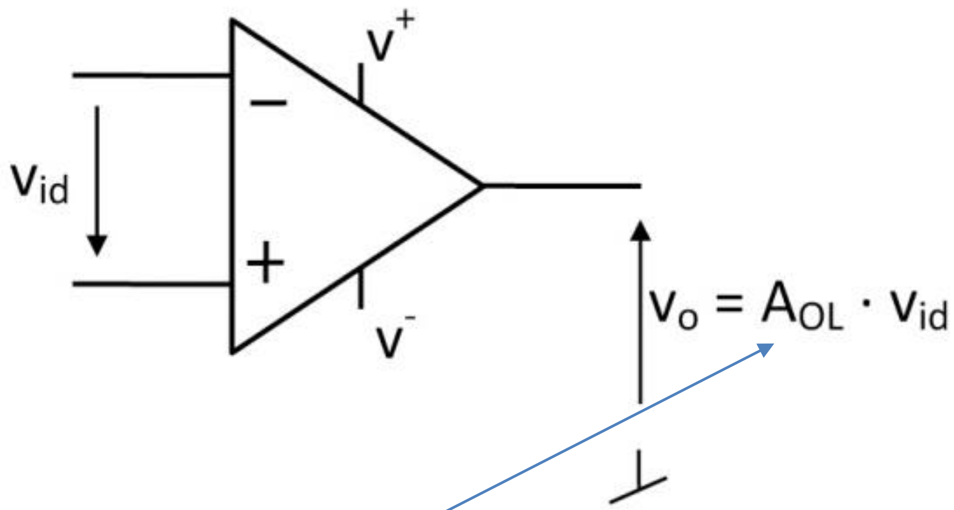
Pause

Generelle betragtninger af forstærker med negativ feedback

- *Indgående forstærkninger*
- *Feedback typer*
- *Baggrund for valg af feedback type (set fra kilde/belastning)*

Forberedelse til lektion 2

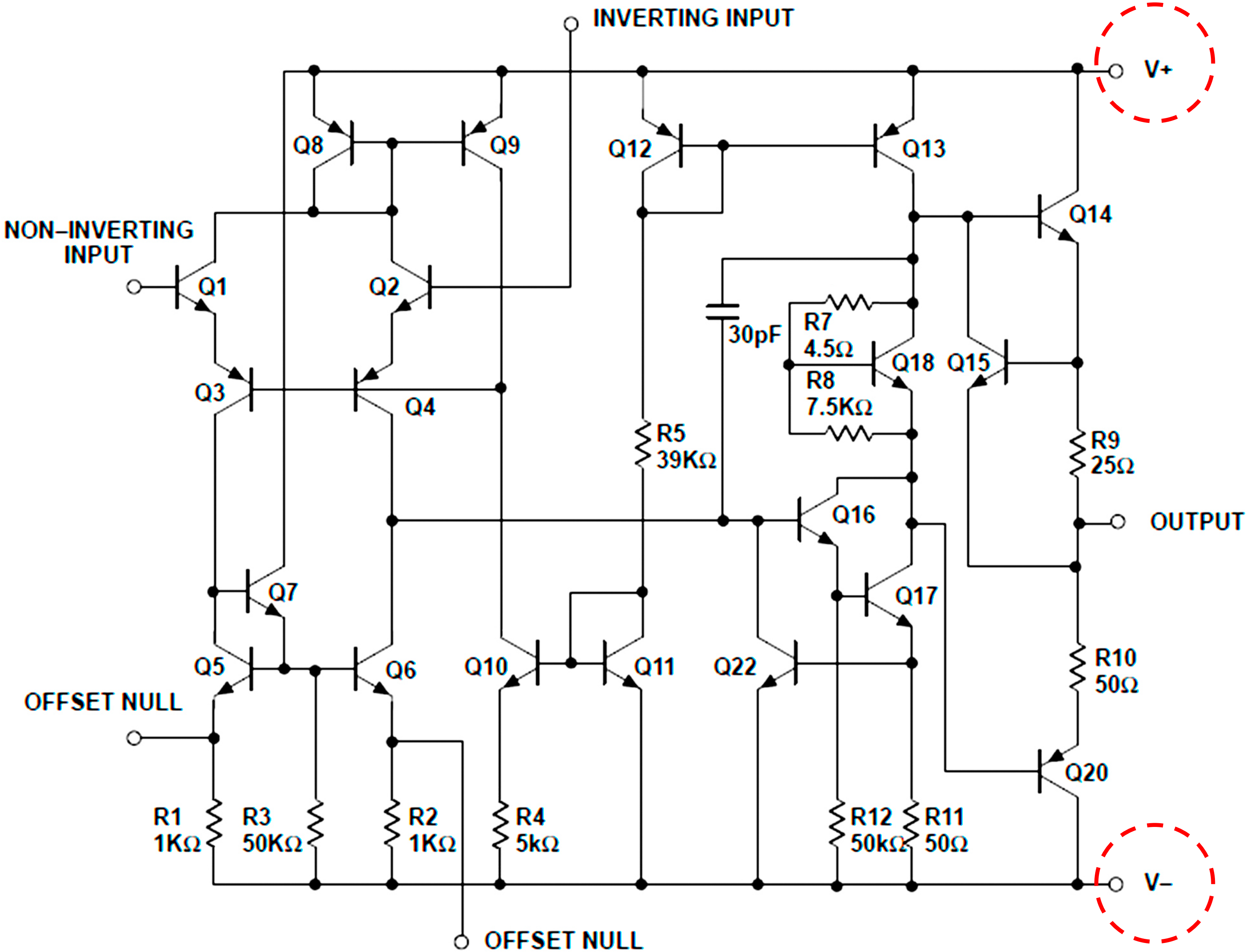
Man kommer langt med Kirchhoff's og Ohm's love, men skal man foretage et ***systematiseret design*** og i denne forbindelse kunne foretage ***kvalificerede komponentvalg***, så er man nødt til ligeledes at kunne ***systematisere sine fejlberegninger***.
Anvender man Op Amps i sin signalbehandling, kan man med fordel relatere de aktuelle egenskaber til den ideelle performance – vurdere hvilke størrelser, der giver anledning til hvilke fejl og måske sætte en kvantitativ størrelse på disse.



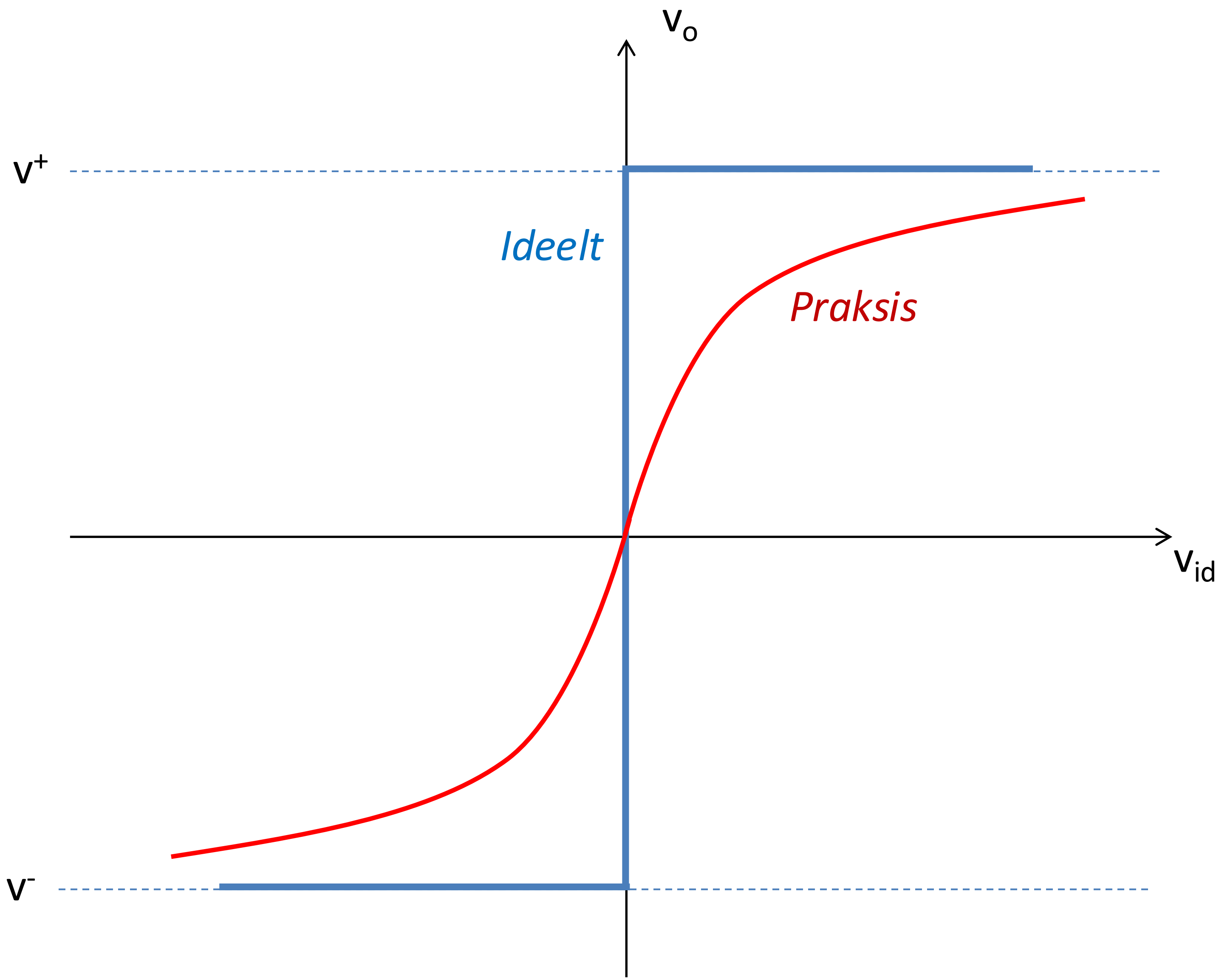
*"**O**pen **L**oop Gain"*

*Åbensløjfeforstærkning - forstærkning **uden** feedback*

*Hvordan ser overføringsfunktionen **v_o som funktion af v_{id}** ud?*
Ideelt? I praksis?

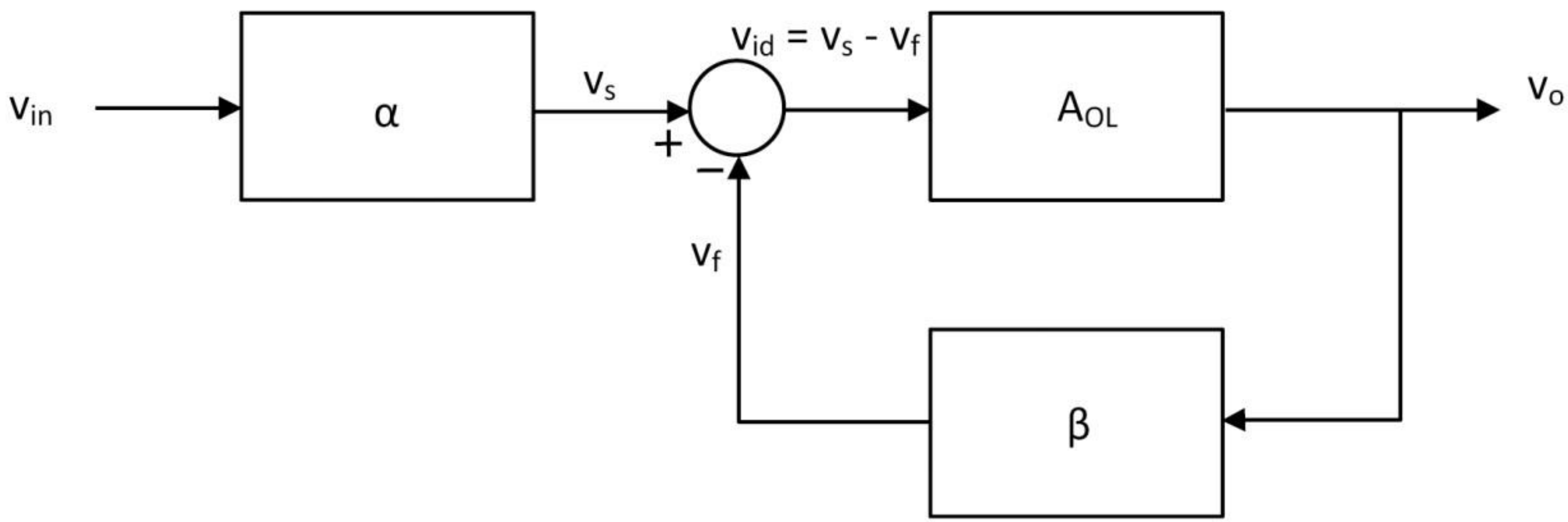


INVERTING INPUT
V+
Q8
Q9
Q12
Q13
Q14
NON–INVERTING
INPUT
Q1
Q2
30pF
R7
4.5Ω
Q18
Q15
Q3
Q4
R8
7.5KΩ
R5
39KΩ
R9
25Ω
Q16
OUTPUT
Q7
Q17
Q5
Q6
Q10
Q11
Q22
R10
50Ω
OFFSET NULL
Q20
R1
1KΩ
R3
50KΩ
R2
1KΩ
R4
5kΩ
R12
50kΩ
R11
50Ω
V–
OFFSET NULL



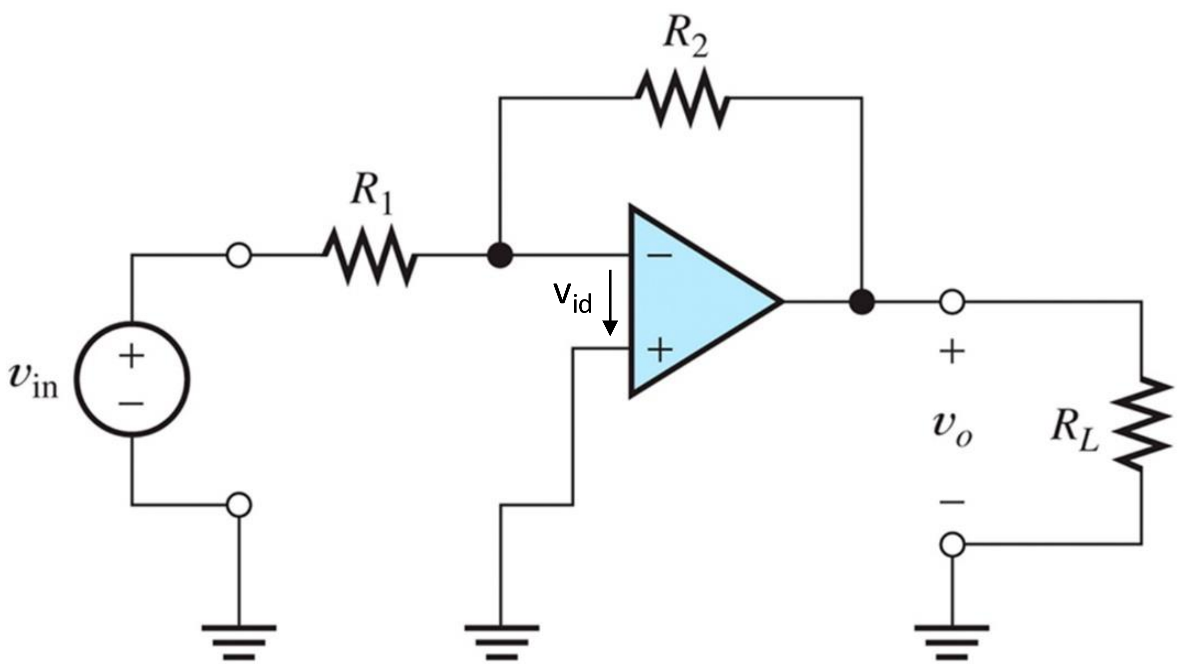
$$v_o = A_{OL} \cdot v_{id} \qquad \Rightarrow \qquad \frac{dv_o}{dv_{id}} = A_{OL}$$

Modkoblet forstærker



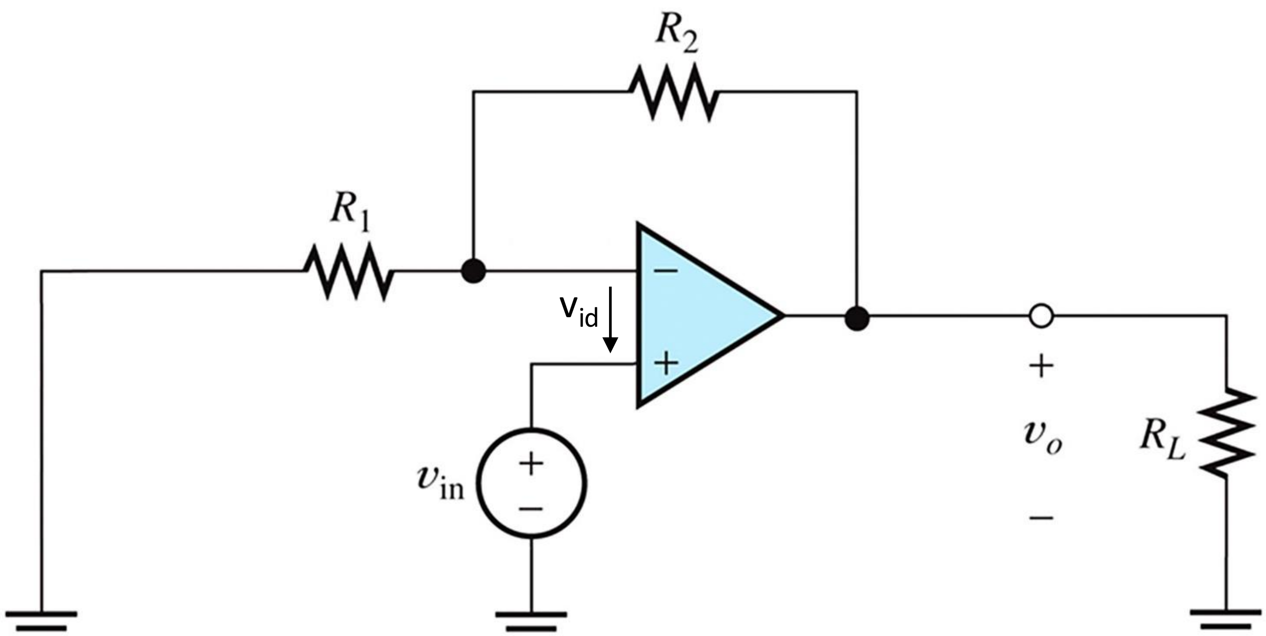
Note: Forstærker med negativ feedback

Inverterende forstærker



α = ? β = ?

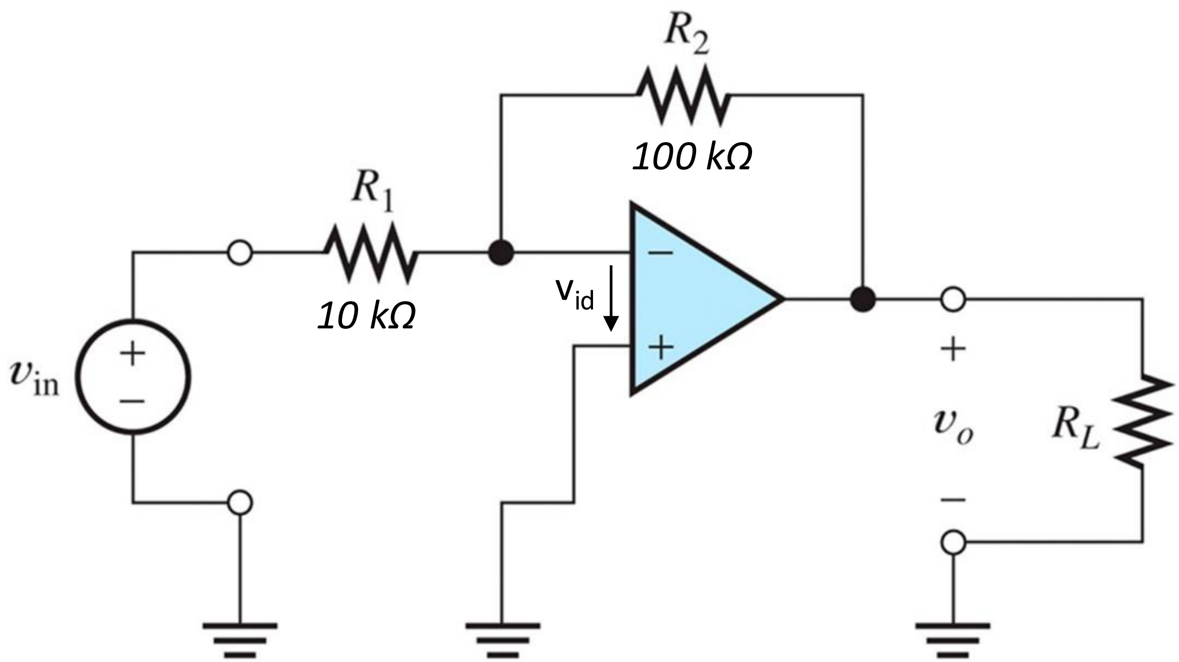
Ikke-inverterende forstærker



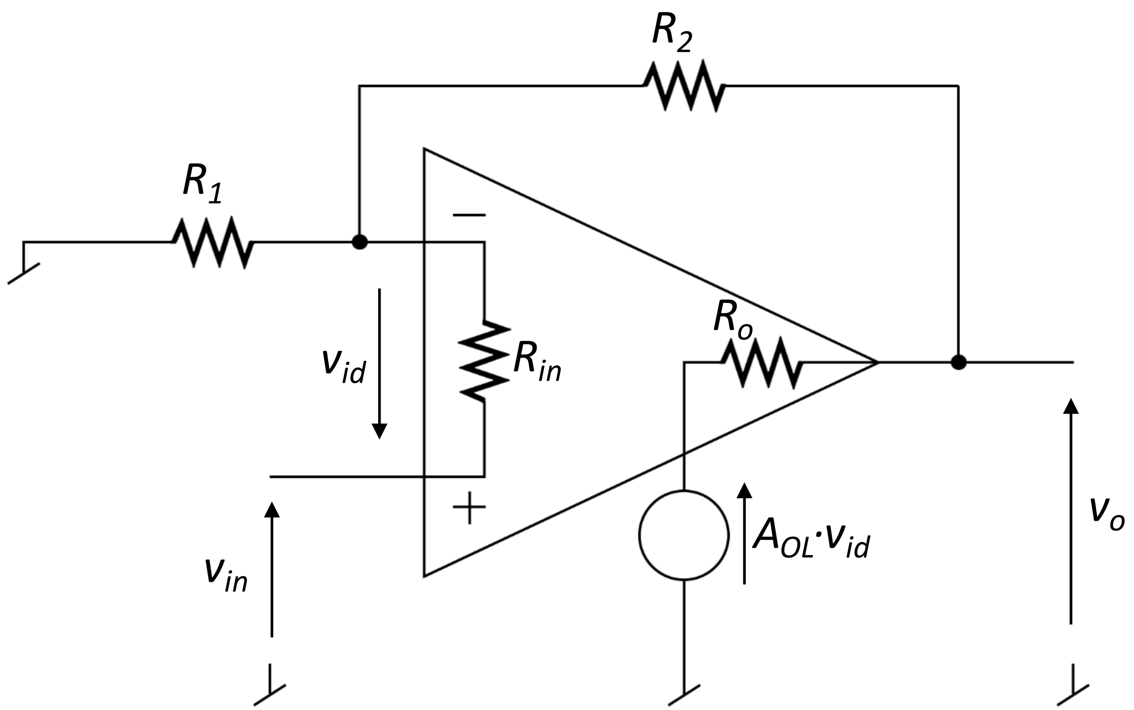
$\alpha = ?$ $\beta = ?$

Sp. 3 fra forberedelsen:

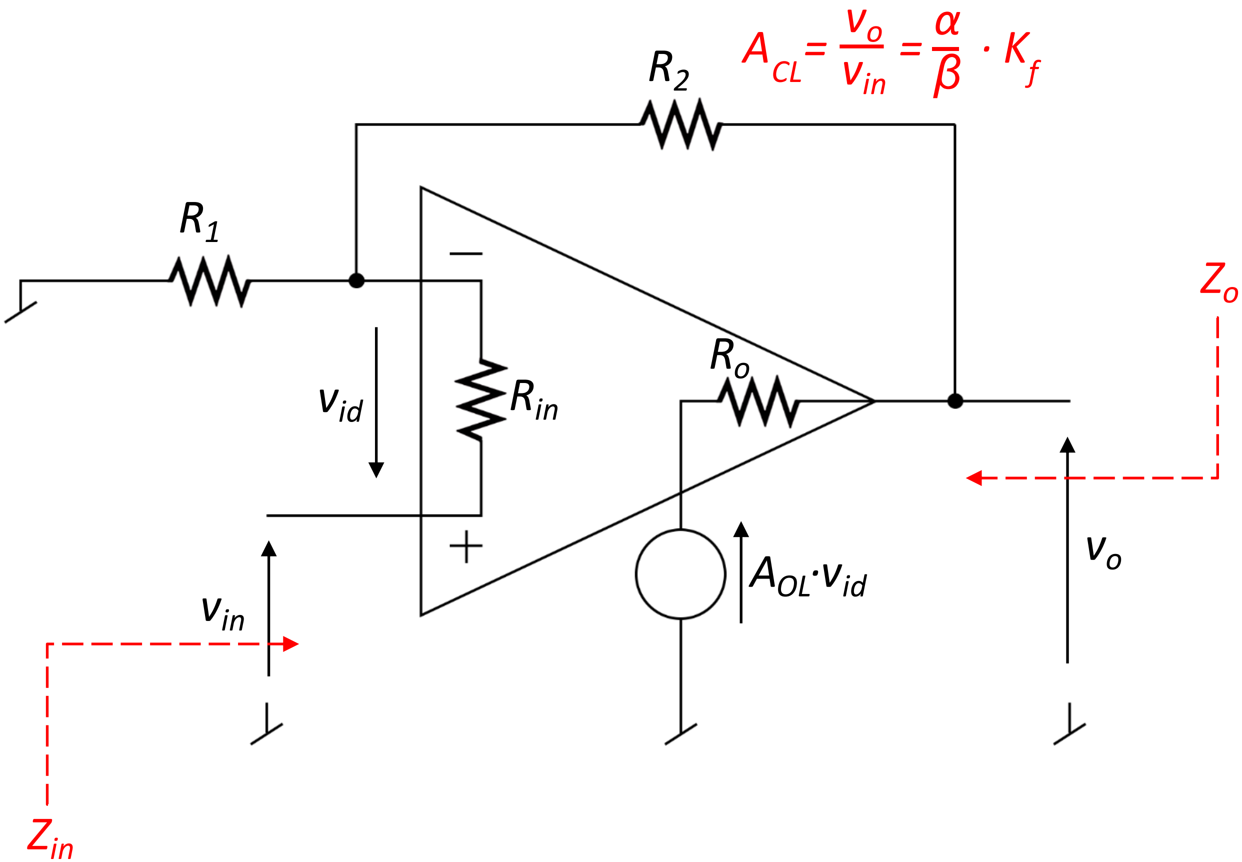
En inverterende forstærker som på figur 2.5 er bygget med R_1 = 10 kΩ og R_2 = 100 kΩ. A_{OL} er 10^6. Hvor stor er afvigelsen fra den ideelle forstærkning?



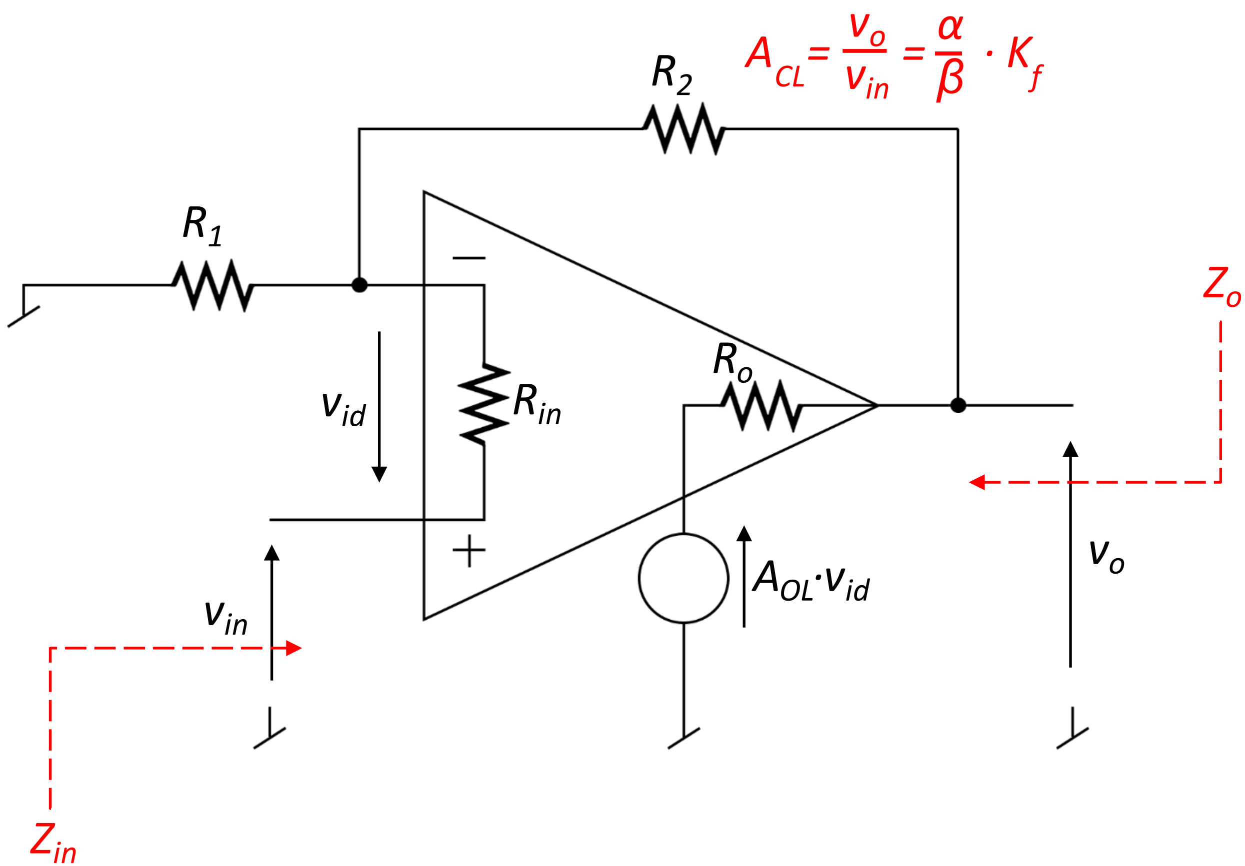
Effekt af negativ feedback på Z_o, Z_{in} og A_{CL}



Effekt af negativ feedback på Z_o, Z_{in} og A_{CL}



Effekt af negativ feedback på Z_o, Z_{in} og A_{CL}

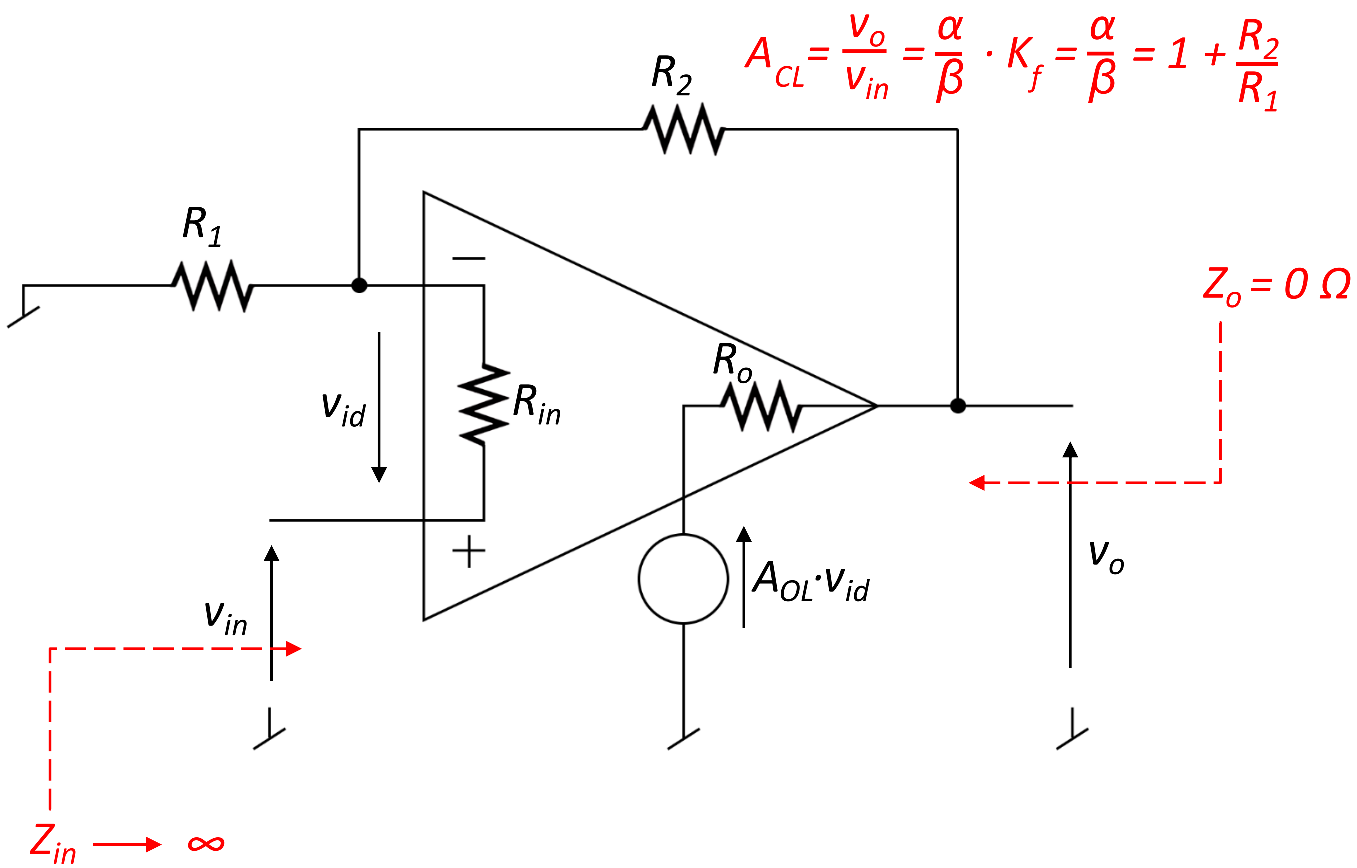


Ideel Op Amp: $A_{OL} \longrightarrow \infty$

$R_{in} \longrightarrow \infty$

$R_o \longrightarrow 0\ \Omega$

Effekt af negativ feedback på Z_o, Z_{in} og A_{CL}



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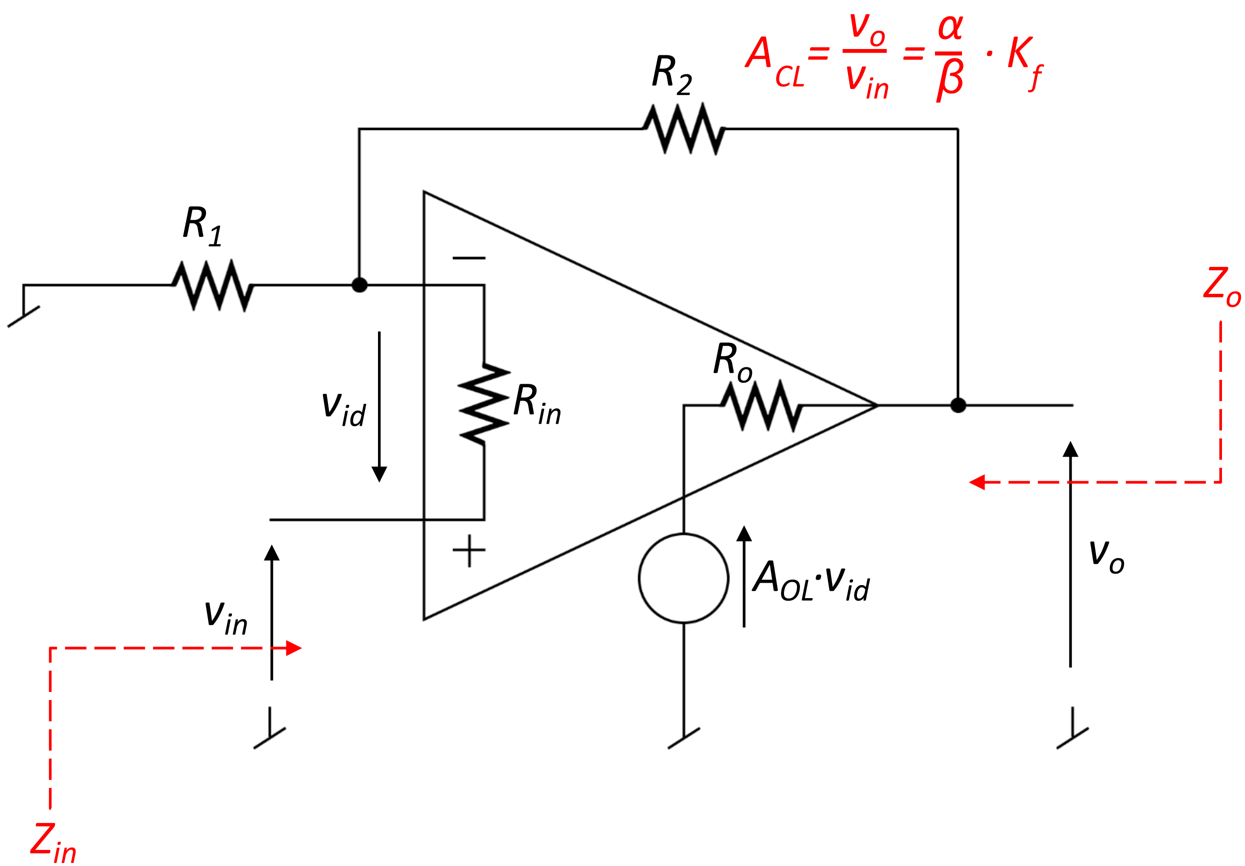
Effekt af negativ feedback på Z_o, Z_{in} og A_{CL}

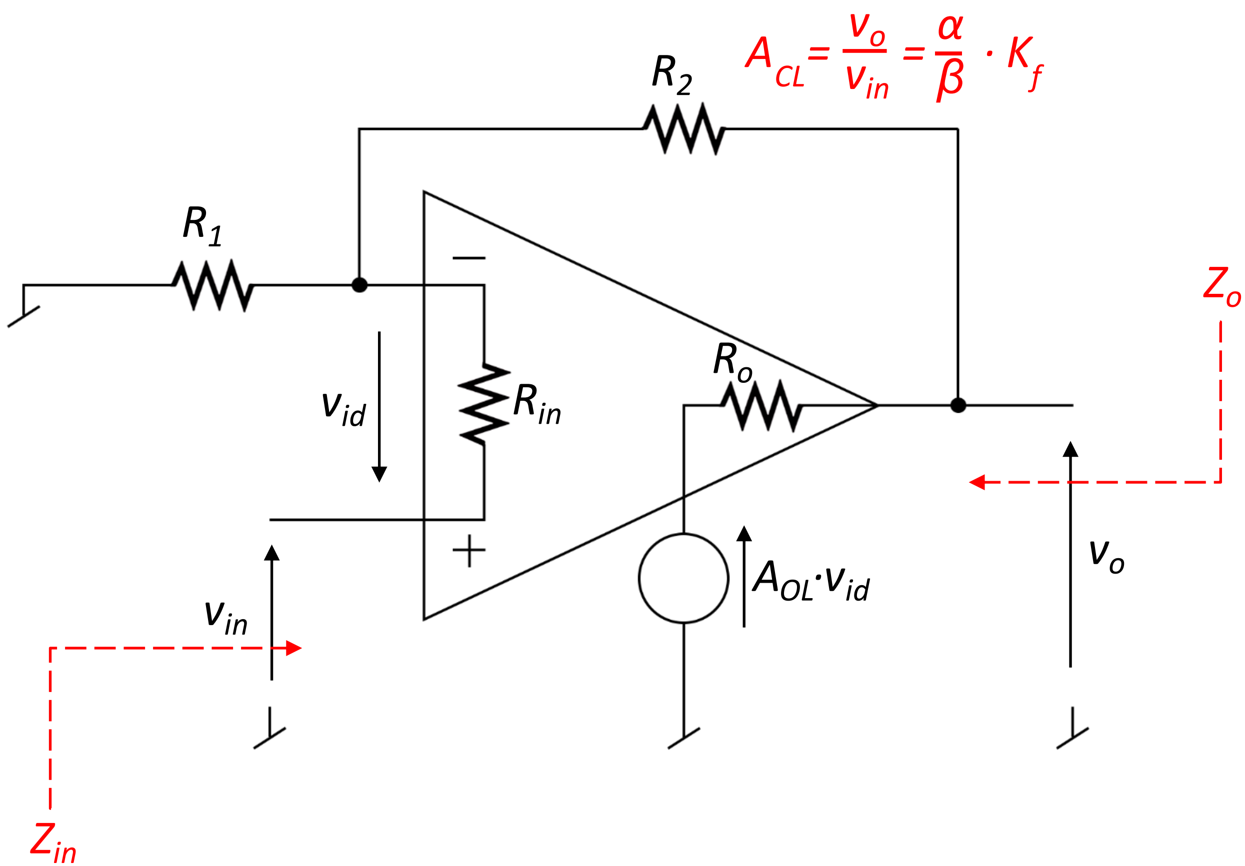


***Ikke** ideel Op Amp:*

A_{OL}	$\neq$	∞
R_{in}	$\neq$	∞
R_o	$\neq$	$0\ \Omega$

Se datablad for µA741

Effekt af negativ feedback på Z_o, Z_{in} og A_{CL}



Ikke *ideel Op Amp:*

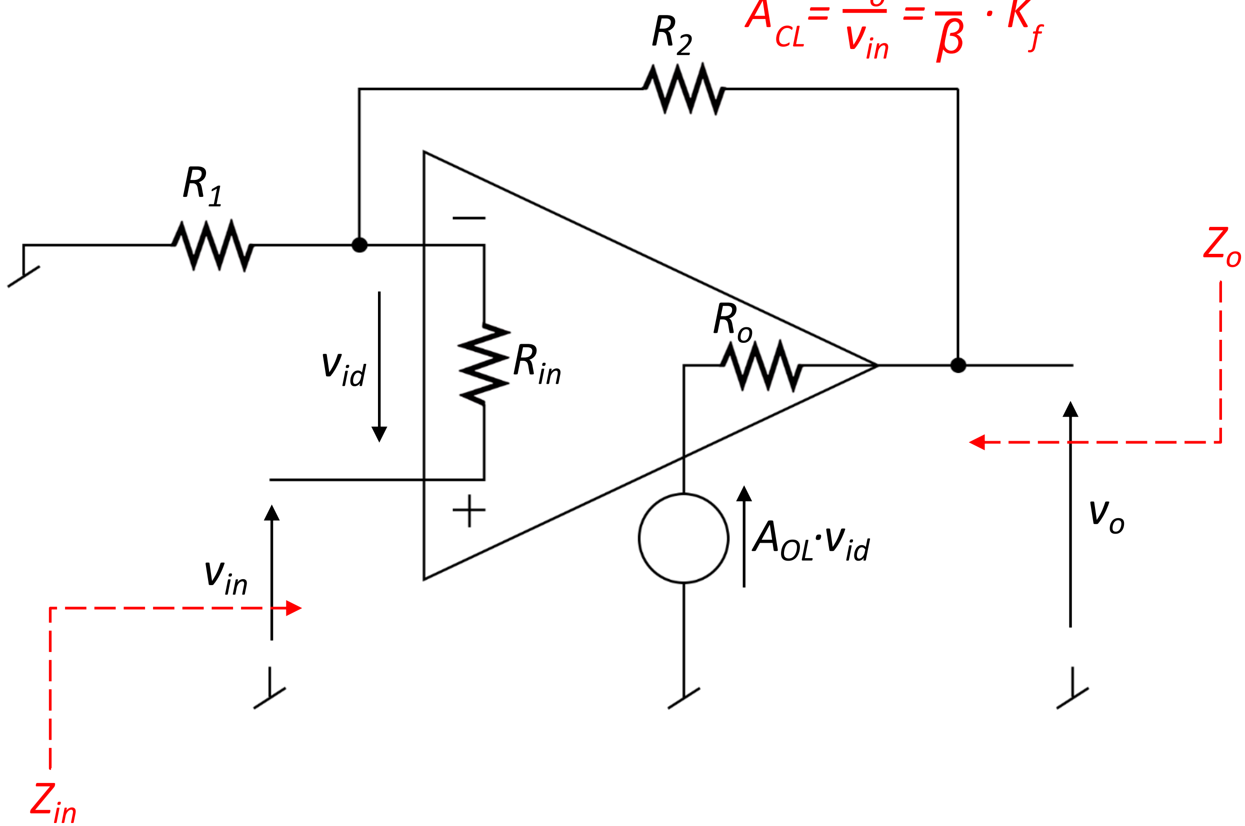
$A_{OL} \neq \infty$

$R_{in} \neq \infty$

$R_o \neq 0\,\Omega$

Effekt af negativ feedback på Z_o, Z_{in} og A_{CL}

$$A_{CL} = \frac{v_o}{v_{in}} = \frac{\alpha}{\beta} \cdot K_f$$



***Ikke** ideel Op Amp:*

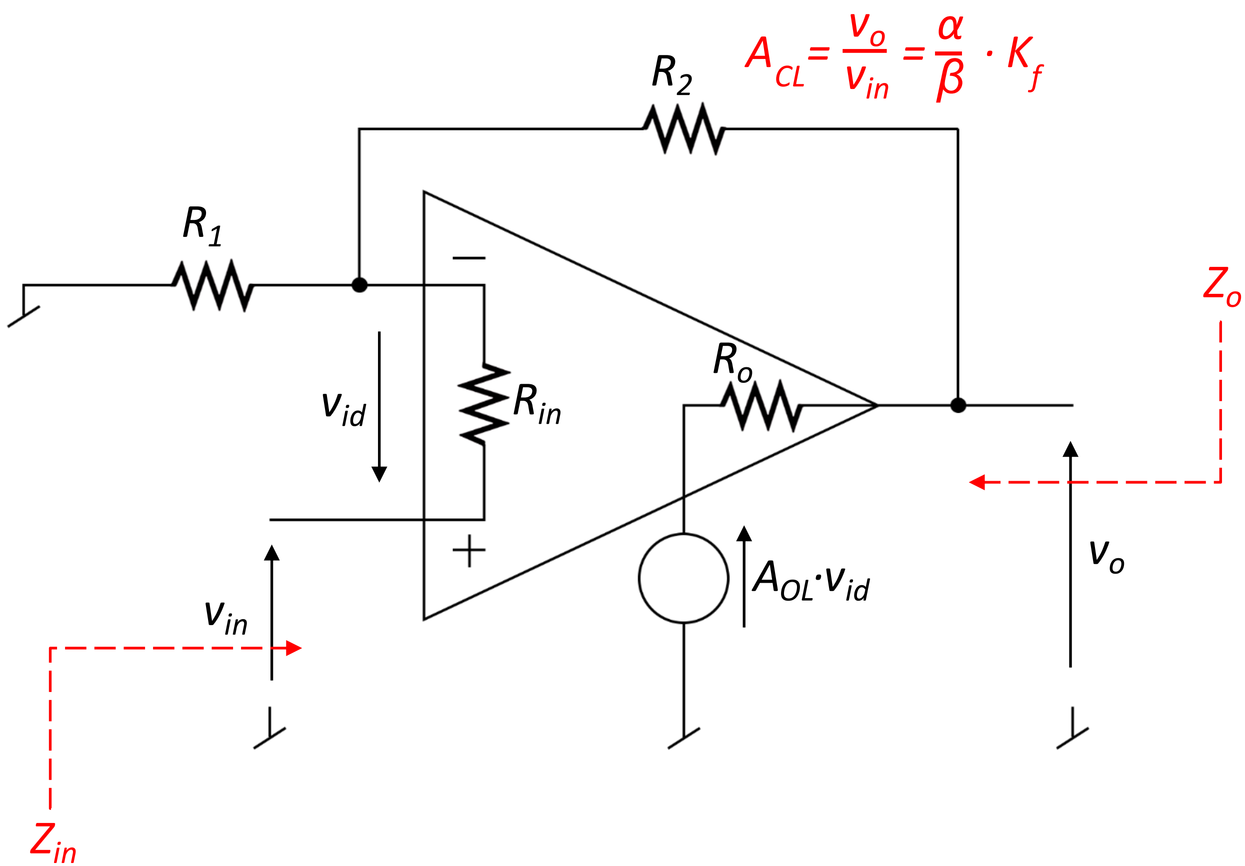
$A_{OL} \neq \infty$

$R_{in} \neq \infty$

$R_o \neq 0\,\Omega$

Betragtninger af Thevenin modstand

Effekt af negativ feedback på Z_o, Z_{in} og A_{CL}



Ikke *ideel Op Amp:*

$A_{OL} \neq \infty$

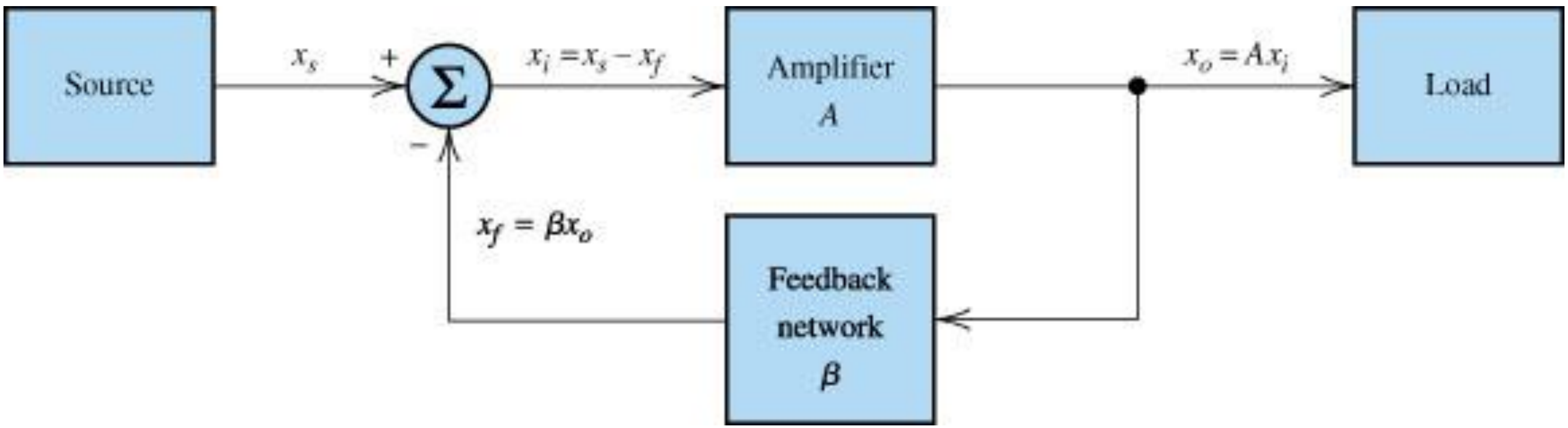
$R_{in} \neq \infty$

$R_o \neq 0\,\Omega$

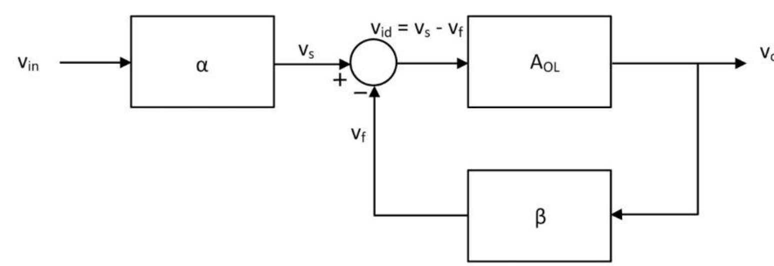
Vi starter lige med at beregne β

Generelle betragtninger af forstærker med negativ feedback

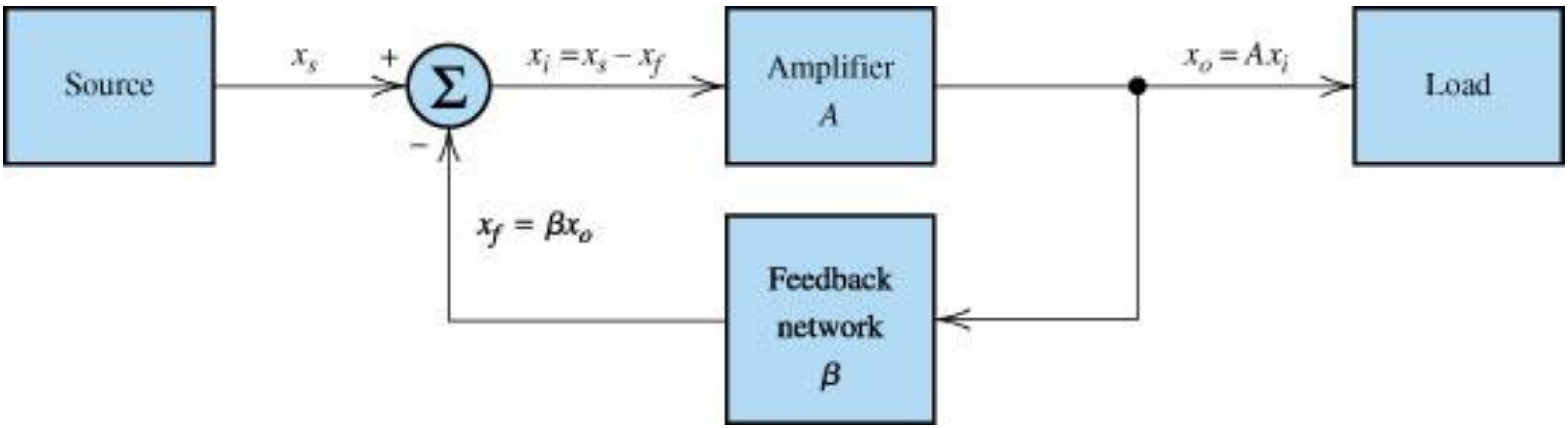
Forstærker med negativ feedback



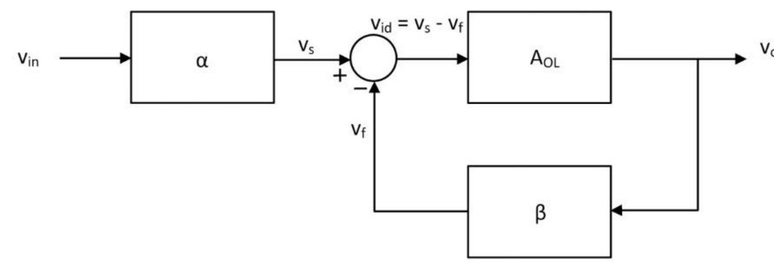
Figur 9.1



Forstærker med negativ feedback

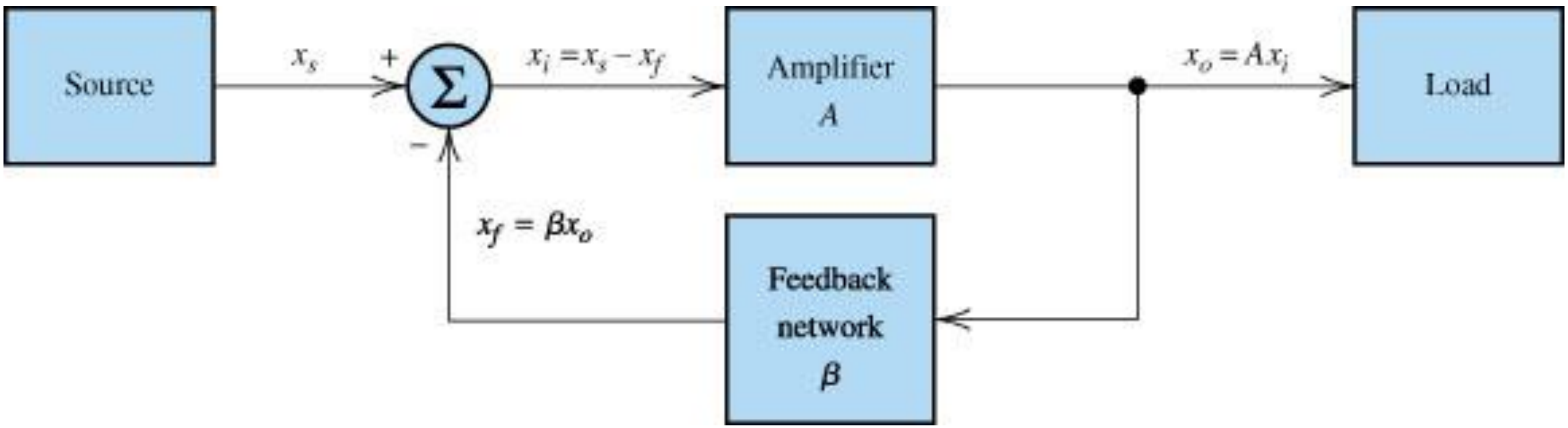


Figur 9.1

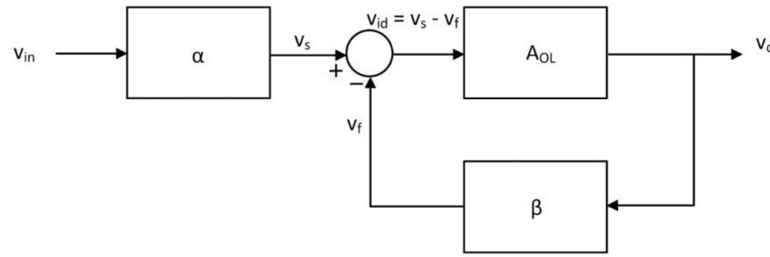


$$A_f = \frac{x_o}{x_s} = \frac{A}{1+\beta\cdot A} = \frac{1}{\beta}\cdot\frac{1}{1+\frac{1}{\beta\cdot A}} \rightarrow \left.\frac{1}{\beta}\right|_{\beta A\rightarrow\infty}$$

Forstærker med negativ feedback



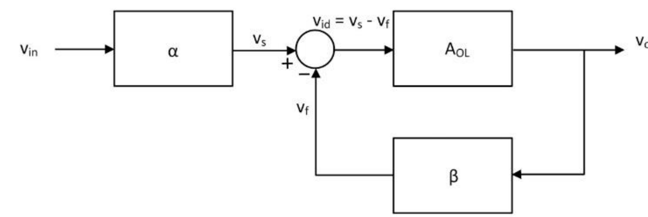
Figur 9.1



Bemærk α = 1 idet x_s betragtes som indgangssignal

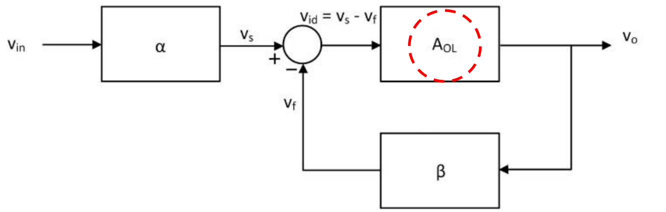
$$A_f = \frac{x_o}{x_s} = \frac{A}{1+\beta\cdot A} = \frac{1}{\beta}\cdot\frac{1}{1+\frac{1}{\beta\cdot A}} \rightarrow \left.\frac{1}{\beta}\right|_{\beta A\rightarrow\infty}$$

$$A_f = \frac{x_o}{x_s} = \frac{A}{1+\beta\cdot A} = \frac{1}{\beta}\cdot\frac{1}{1+\frac{1}{\beta\cdot A}} \rightarrow \left.\frac{1}{\beta}\right|_{\beta A\rightarrow\infty}$$



$$A_f = \frac{x_o}{x_s} = \frac{A}{1+\beta\cdot A} = \frac{1}{\beta}\cdot\frac{1}{1+\frac{1}{\beta\cdot A}} \rightarrow \left.\frac{1}{\beta}\right|_{\beta A\to\infty}$$

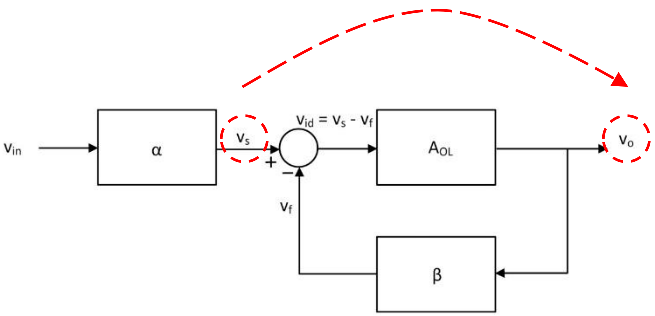
A: ***Åben**sløjfeforstærkningen (A$_{OL}$)*



$$A_f = \frac{x_o}{x_s} = \frac{A}{1+\beta\cdot A} = \frac{1}{\beta}\cdot\frac{1}{1+\frac{1}{\beta\cdot A}} \rightarrow \left.\frac{1}{\beta}\right|_{\beta A\rightarrow\infty}$$

A: ***Åben**sløjfeforstærkningen* *(A_{OL})*

A_f: ***Lukket**sløjfeforstærkningen* *(A_{CL})*

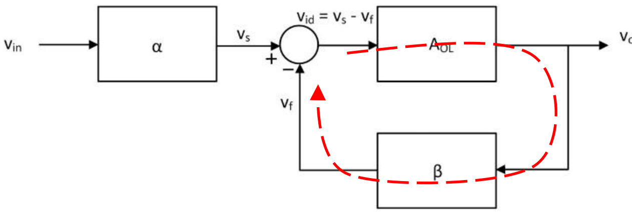


$$A_f = \frac{x_o}{x_s} = \frac{A}{1+\beta \cdot A} = \frac{1}{\beta} \cdot \frac{1}{1+\frac{1}{\beta \cdot A}} \rightarrow \left.\frac{1}{\beta}\right|_{\beta A \rightarrow \infty}$$

A: ***Åben**sløjfeforstærkningen (A_{OL})*

A_f: ***Lukket**sløjfeforstærkningen (A_{CL})*

βA: ***Sløjfe**forstærkningen (βA_{OL})*

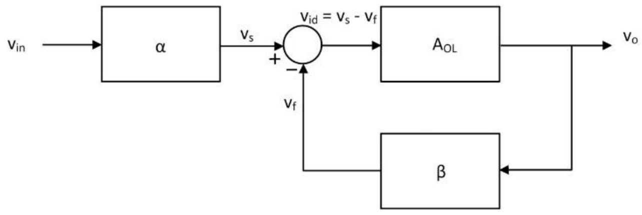


$$A_f = \frac{x_o}{x_s} = \frac{A}{1+\beta \cdot A} = \frac{1}{\beta} \cdot \frac{1}{1+\frac{1}{\beta \cdot A}} \rightarrow \left.\frac{1}{\beta}\right|_{\beta A \rightarrow \infty}$$

A: **Åben**sløjfeforstærkningen (A_{OL})

A_f: **Lukket**sløjfeforstærkningen (A_{CL})

βA **Sløjfe**forstærkningen (βA_{OL})



***A_f** er hele kredsløbets performance set fra terminalerne udefra.*

$$\beta A >> 1$$

Lukketsløjfeforstærkningen A_f bliver uafhængig af åbensløjfeforstærkningen A

***A** afhænger ofte **markant** af den aktive komponents parametre (A_{OL})*

*β er typisk bestemt af **passive** komponenter: R, C, etc.*

*β er typisk bestemt af **passive** komponenter: R, C, etc.*

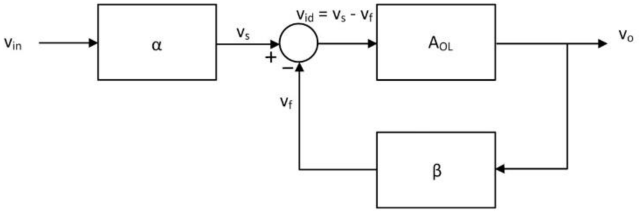
Hvis:

$$A_f = \frac{x_o}{x_s} = \frac{A}{1+\beta\cdot A} = \frac{1}{\beta}\cdot\frac{1}{1+\frac{1}{\beta\cdot A}} \rightarrow \left.\frac{1}{\beta}\right|_{\beta A\rightarrow\infty}$$

*…kan man udskifte den **aktive komponent** og opnå **uændret performance**, hvis blot…*

$$\boxed{\beta A >> 1}$$

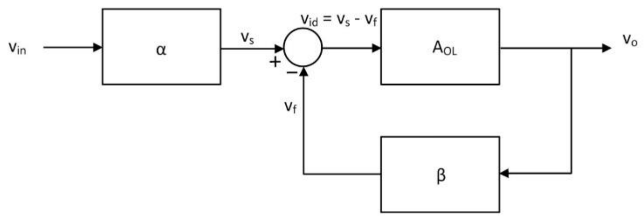
Feedback typer



*Hvordan feedback signalet **samples***

Spænding/strøm

Feedback typer

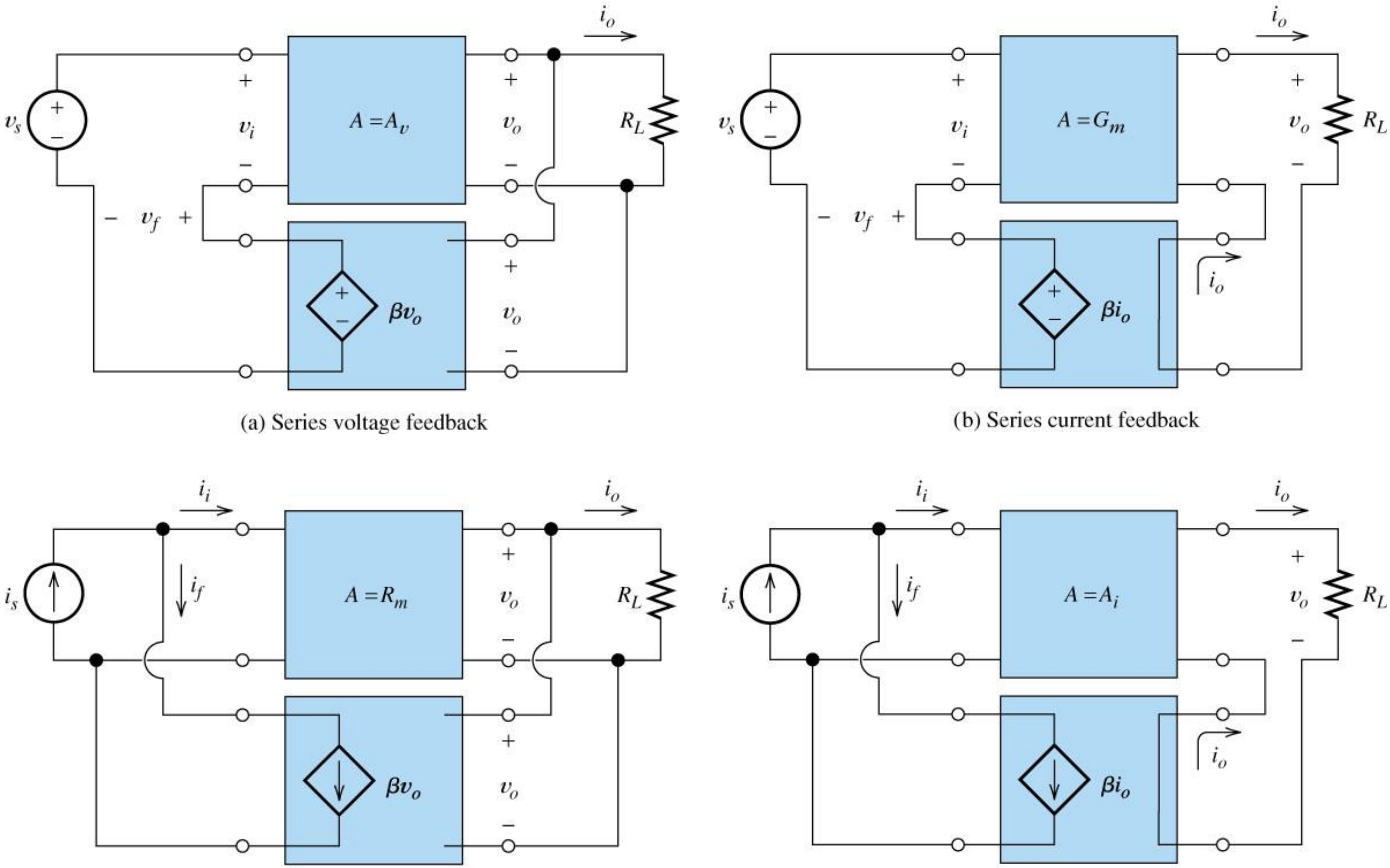


*Hvordan feedback signalet **samples***

Spænding/strøm

*Hvordan feedback signalet **føres tilbage***

Serie/parallel



(a) Series voltage feedback

(b) Series current feedback

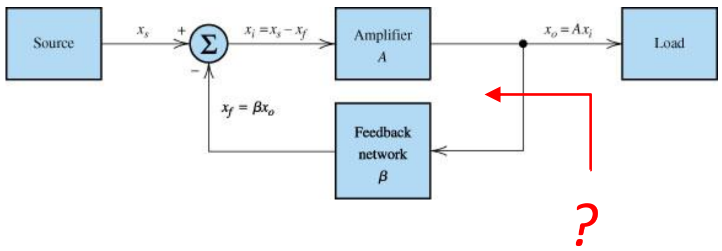
(c) Parallel voltage feedback

(d) Parallel current feedback

Figur 9.14

Baggrund for valg af feedback type

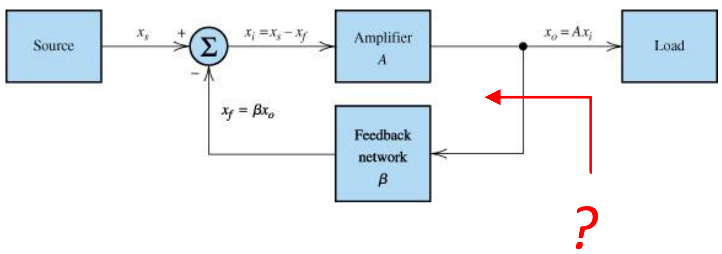
*Hvordan skal kredsløbet se ud som **kilde**?*



Set fra R_L

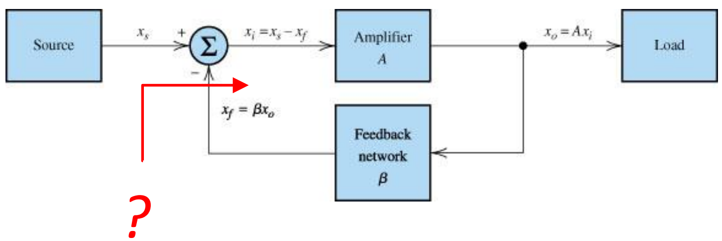
Baggrund for valg af feedback type

*Hvordan skal kredsløbet se ud som **kilde**?*



Set fra R_L

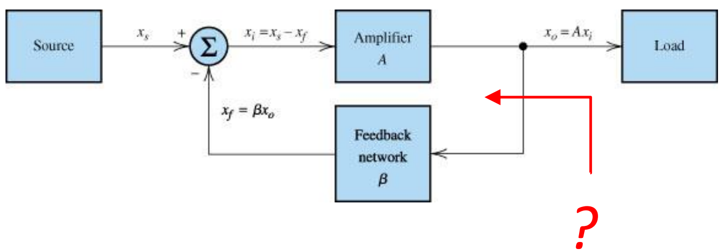
*Hvordan skal kredsløbet se ud som **belastning**?*



Set fra v_s

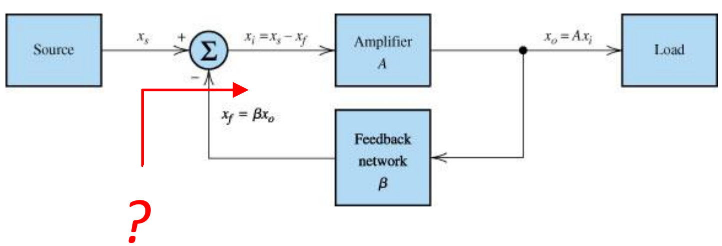
Baggrund for valg af feedback type

*Hvordan skal kredsløbet se ud som **kilde**?*



Set fra R_L

*Hvordan skal kredsløbet se ud som **belastning**?*



Set fra v_s

Thevenin og Norton betragtninger →

Table 9.1. Effects of Feedback[a]

Feedback Type	x_s	x_o	Gain Stabilized	Input Impedance	Output Impedance	Ideal Amplifier
Series voltage	v_s	v_o	$A_{vf} = \dfrac{A_v}{1 + A_v\beta}$	$R_i(1 + A_v\beta)$	$\dfrac{R_o}{1 + \beta A_{voc}}$	Voltage
Series current	v_s	i_o	$G_{mf} = \dfrac{G_m}{1 + G_m\beta}$	$R_i(1 + G_m\beta)$	$R_o(1 + \beta G_{msc})$	Transconductance
Parallel voltage	i_s	v_o	$R_{mf} = \dfrac{R_m}{1 + R_m\beta}$	$\dfrac{R_i}{1 + R_m\beta}$	$\dfrac{R_o}{1 + \beta R_{moc}}$	Transresistance
Parallel current	i_s	i_o	$A_{if} = \dfrac{A_i}{1 + A_i\beta}$	$\dfrac{R_i}{1 + A_i\beta}$	$R_o(1 + \beta A_{isc})$	Current

[a] Formulas given assume an ideal controlled source for the feedback network (as shown in Figure 9.14), zero source impedance for series feedback, and infinite source impedance for parallel feedback. Gains with subscripts sc and oc are for short-circuit and open-circuit loads, respectively. The gains A_v, G_m, R_m, and A_i are for the actual load.

Vær opmærksom på type af forstærkeren i reguleringssløjfen!

Table 9.1. Effects of Feedback[a]

Feedback Type	x_s	x_o	Gain Stabilized	Input Impedance	Output Impedance	Ideal Amplifier
Series voltage	v_s	v_o	$A_{vf} = \dfrac{A_v}{1 + A_v\beta}$	$R_i(1 + A_v\beta)$	$\dfrac{R_o}{1 + \beta A_{voc}}$	Voltage
Series current	v_s	i_o	$G_{mf} = \dfrac{G_m}{1 + G_m\beta}$	$R_i(1 + G_m\beta)$	$R_o(1 + \beta G_{msc})$	Transconductance
Parallel voltage	i_s	v_o	$R_{mf} = \dfrac{R_m}{1 + R_m\beta}$	$\dfrac{R_i}{1 + R_m\beta}$	$\dfrac{R_o}{1 + \beta R_{moc}}$	Transresistance
Parallel current	i_s	i_o	$A_{if} = \dfrac{A_i}{1 + A_i\beta}$	$\dfrac{R_i}{1 + A_i\beta}$	$R_o(1 + \beta A_{isc})$	Current

[a] Formulas given assume an ideal controlled source for the feedback network (as shown in Figure 9.14), zero source impedance for series feedback, and infinite source impedance for parallel feedback. Gains with subscripts sc and oc are for short-circuit and open-circuit loads, respectively. The gains A_v, G_m, R_m, and A_i are for the actual load.

$R_{if} \rightarrow \infty$

Table 9.1. Effects of Feedback[a]

Feedback Type	x_s	x_o	Gain Stabilized	Input Impedance	Output Impedance	Ideal Amplifier
Series voltage	v_s	v_o	$A_{vf} = \dfrac{A_v}{1 + A_v\beta}$	$\boxed{R_i(1 + A_v\beta)}$	$\dfrac{R_o}{1 + \beta A_{voc}}$	Voltage
Series current	v_s	i_o	$G_{mf} = \dfrac{G_m}{1 + G_m\beta}$	$R_i(1 + G_m\beta)$	$R_o(1 + \beta G_{msc})$	Transconductance
Parallel voltage	i_s	v_o	$R_{mf} = \dfrac{R_m}{1 + R_m\beta}$	$\dfrac{R_i}{1 + R_m\beta}$	$\dfrac{R_o}{1 + \beta R_{moc}}$	Transresistance
Parallel current	i_s	i_o	$A_{if} = \dfrac{A_i}{1 + A_i\beta}$	$\dfrac{R_i}{1 + A_i\beta}$	$R_o(1 + \beta A_{isc})$	Current

[a] Formulas given assume an ideal controlled source for the feedback network (as shown in Figure 9.14), zero source impedance for series feedback, and infinite source impedance for parallel feedback. Gains with subscripts sc and oc are for short-circuit and open-circuit loads, respectively. The gains A_v, G_m, R_m, and A_i are for the actual load.

Table 9.1. Effects of Feedback[a]

Feedback Type	x_s	x_o	Gain Stabilized	Input Impedance	Output Impedance	Ideal Amplifier
Series voltage	v_s	v_o	$A_{vf} = \frac{A_v}{1 + A_v\beta}$	$R_i(1 + A_v\beta)$	$\frac{R_o}{1 + \beta A_{voc}}$	Voltage
Series current	v_s	i_o	$G_{mf} = \frac{G_m}{1 + G_m\beta}$	$R_i(1 + G_m\beta)$	$R_o(1 + \beta G_{msc})$	Transconductance
Parallel voltage	i_s	v_o	$R_{mf} = \frac{R_m}{1 + R_m\beta}$	$\boxed{\frac{R_i}{1 + R_m\beta}}$	$\frac{R_o}{1 + \beta R_{moc}}$	Transresistance
Parallel current	i_s	i_o	$A_{if} = \frac{A_i}{1 + A_i\beta}$	$\frac{R_i}{1 + A_i\beta}$	$R_o(1 + \beta A_{isc})$	Current

[a] Formulas given assume an ideal controlled source for the feedback network (as shown in Figure 9.14), zero source impedance for series feedback, and infinite source impedance for parallel feedback. Gains with subscripts sc and oc are for short-circuit and open-circuit loads, respectively. The gains A_v, G_m, R_m, and A_i are for the actual load.

$R_{if} \to 0\,\Omega$

Table 9.1. Effects of Feedback[a]

Feedback Type	x_s	x_o	Gain Stabilized	Input Impedance	Output Impedance	Ideal Amplifier
Series voltage	v_s	v_o	$A_{vf} = \dfrac{A_v}{1 + A_v\beta}$	$R_i(1 + A_v\beta)$	$\dfrac{R_o}{1 + \beta A_{voc}}$	Voltage
Series current	v_s	i_o	$G_{mf} = \dfrac{G_m}{1 + G_m\beta}$	$R_i(1 + G_m\beta)$	$R_o(1 + \beta G_{msc})$	Transconductance
Parallel voltage	i_s	v_o	$R_{mf} = \dfrac{R_m}{1 + R_m\beta}$	$\boxed{\dfrac{R_i}{1 + R_m\beta}}$	$\dfrac{R_o}{1 + \beta R_{moc}}$	Transresistance
Parallel current	i_s	i_o	$A_{if} = \dfrac{A_i}{1 + A_i\beta}$	$\dfrac{R_i}{1 + A_i\beta}$	$R_o(1 + \beta A_{isc})$	Current

[a] Formulas given assume an ideal controlled source for the feedback network (as shown in Figure 9.14), zero source impedance for series feedback, and infinite source impedance for parallel feedback. Gains with subscripts sc and oc are for short-circuit and open-circuit loads, respectively. The gains A_v, G_m, R_m, and A_i are for the actual load.

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Feedback Type	x_s	x_o	Gain Stabilized	Input Impedance	Output Impedance	Ideal Amplifier
Series voltage	v_s	v_o	$A_{vf} = \dfrac{A_v}{1 + A_v\beta}$	$R_i(1 + A_v\beta)$	$\boxed{\dfrac{R_o}{1 + \beta A_{voc}}}$	Voltage
Series current	v_s	i_o	$G_{mf} = \dfrac{G_m}{1 + G_m\beta}$	$R_i(1 + G_m\beta)$	$R_o(1 + \beta G_{msc})$	Transconductance
Parallel voltage	i_s	v_o	$R_{mf} = \dfrac{R_m}{1 + R_m\beta}$	$\dfrac{R_i}{1 + R_m\beta}$	$\dfrac{R_o}{1 + \beta R_{moc}}$	Transresistance
Parallel current	i_s	i_o	$A_{if} = \dfrac{A_i}{1 + A_i\beta}$	$\dfrac{R_i}{1 + A_i\beta}$	$R_o(1 + \beta A_{isc})$	Current

[a] Formulas given assume an ideal controlled source for the feedback network (as shown in Figure 9.14), zero source impedance for series feedback, and infinite source impedance for parallel feedback. Gains with subscripts sc and oc are for short-circuit and open-circuit loads, respectively. The gains A_v, G_m, R_m, and A_i are for the actual load.

$R_{of} \rightarrow 0\,\Omega$

Table 9.1. Effects of Feedback[a]

Feedback Type	x_s	x_o	Gain Stabilized	Input Impedance	Output Impedance	Ideal Amplifier
Series $\boxed{\text{voltage}}$	v_s	v_o	$A_{vf} = \dfrac{A_v}{1 + A_v\beta}$	$R_i(1 + A_v\beta)$	$\boxed{\dfrac{R_o}{1 + \beta A_{voc}}}$	Voltage
Series current	v_s	i_o	$G_{mf} = \dfrac{G_m}{1 + G_m\beta}$	$R_i(1 + G_m\beta)$	$R_o(1 + \beta G_{msc})$	Transconductance
Parallel voltage	i_s	v_o	$R_{mf} = \dfrac{R_m}{1 + R_m\beta}$	$\dfrac{R_i}{1 + R_m\beta}$	$\dfrac{R_o}{1 + \beta R_{moc}}$	Transresistance
Parallel current	i_s	i_o	$A_{if} = \dfrac{A_i}{1 + A_i\beta}$	$\dfrac{R_i}{1 + A_i\beta}$	$R_o(1 + \beta A_{isc})$	Current

[a] Formulas given assume an ideal controlled source for the feedback network (as shown in Figure 9.14), zero source impedance for series feedback, and infinite source impedance for parallel feedback. Gains with subscripts sc and oc are for short-circuit and open-circuit loads, respectively. The gains A_v, G_m, R_m, and A_i are for the actual load.

$R_{of} \rightarrow 0\ \Omega$

Ideel spændingskilde

Table 9.1. Effects of Feedback[a]

Feedback Type	x_s	x_o	Gain Stabilized	Input Impedance	Output Impedance	Ideal Amplifier
Series $\boxed{\text{voltage}}$	v_s	v_o	$A_{vf} = \dfrac{A_v}{1 + A_v\beta}$	$R_i(1 + A_v\beta)$	$\boxed{\dfrac{R_o}{1 + \beta A_{voc}}}$	Voltage
Series current	v_s	i_o	$G_{mf} = \dfrac{G_m}{1 + G_m\beta}$	$R_i(1 + G_m\beta)$	$R_o(1 + \beta G_{msc})$	Transconductance
Parallel voltage	i_s	v_o	$R_{mf} = \dfrac{R_m}{1 + R_m\beta}$	$\dfrac{R_i}{1 + R_m\beta}$	$\dfrac{R_o}{1 + \beta R_{moc}}$	Transresistance
Parallel current	i_s	i_o	$A_{if} = \dfrac{A_i}{1 + A_i\beta}$	$\dfrac{R_i}{1 + A_i\beta}$	$R_o(1 + \beta A_{isc})$	Current

[a] Formulas given assume an ideal controlled source for the feedback network (as shown in Figure 9.14), zero source impedance for series feedback, and infinite source impedance for parallel feedback. Gains with subscripts sc and oc are for short-circuit and open-circuit loads, respectively. The gains A_v, G_m, R_m, and A_i are for the actual load.

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Feedback Type	x_s	x_o	Gain Stabilized	Input Impedance	Output Impedance	Ideal Amplifier
Series voltage	v_s	v_o	$A_{vf} = \dfrac{A_v}{1 + A_v\beta}$	$R_i(1 + A_v\beta)$	$\dfrac{R_o}{1 + \beta A_{voc}}$	Voltage
Series current	v_s	i_o	$G_{mf} = \dfrac{G_m}{1 + G_m\beta}$	$R_i(1 + G_m\beta)$	$R_o(1 + \beta G_{msc})$	Transconductance
Parallel voltage	i_s	v_o	$R_{mf} = \dfrac{R_m}{1 + R_m\beta}$	$\dfrac{R_i}{1 + R_m\beta}$	$\dfrac{R_o}{1 + \beta R_{moc}}$	Transresistance
Parallel current	i_s	i_o	$A_{if} = \dfrac{A_i}{1 + A_i\beta}$	$\dfrac{R_i}{1 + A_i\beta}$	$R_o(1 + \beta A_{isc})$	Current

[a] Formulas given assume an ideal controlled source for the feedback network (as shown in Figure 9.14), zero source impedance for series feedback, and infinite source impedance for parallel feedback. Gains with subscripts sc and oc are for short-circuit and open-circuit loads, respectively. The gains A_v, G_m, R_m, and A_i are for the actual load.

$R_{of} \to \infty$

Table 9.1. Effects of Feedback[a]

Feedback Type	x_s	x_o	Gain Stabilized	Input Impedance	Output Impedance	Ideal Amplifier
Series voltage	v_s	v_o	$A_{vf} = \dfrac{A_v}{1 + A_v\beta}$	$R_i(1 + A_v\beta)$	$\dfrac{R_o}{1 + \beta A_{voc}}$	Voltage
Series current	v_s	i_o	$G_{mf} = \dfrac{G_m}{1 + G_m\beta}$	$R_i(1 + G_m\beta)$	$\boxed{R_o(1 + \beta G_{msc})}$	Transconductance
Parallel voltage	i_s	v_o	$R_{mf} = \dfrac{R_m}{1 + R_m\beta}$	$\dfrac{R_i}{1 + R_m\beta}$	$\dfrac{R_o}{1 + \beta R_{moc}}$	Transresistance
Parallel current	i_s	i_o	$A_{if} = \dfrac{A_i}{1 + A_i\beta}$	$\dfrac{R_i}{1 + A_i\beta}$	$R_o(1 + \beta A_{isc})$	Current

[a] Formulas given assume an ideal controlled source for the feedback network (as shown in Figure 9.14), zero source impedance for series feedback, and infinite source impedance for parallel feedback. Gains with subscripts sc and oc are for short-circuit and open-circuit loads, respectively. The gains A_v, G_m, R_m, and A_i are for the actual load.

$R_{of} \rightarrow \infty$

Ideel strømkilde

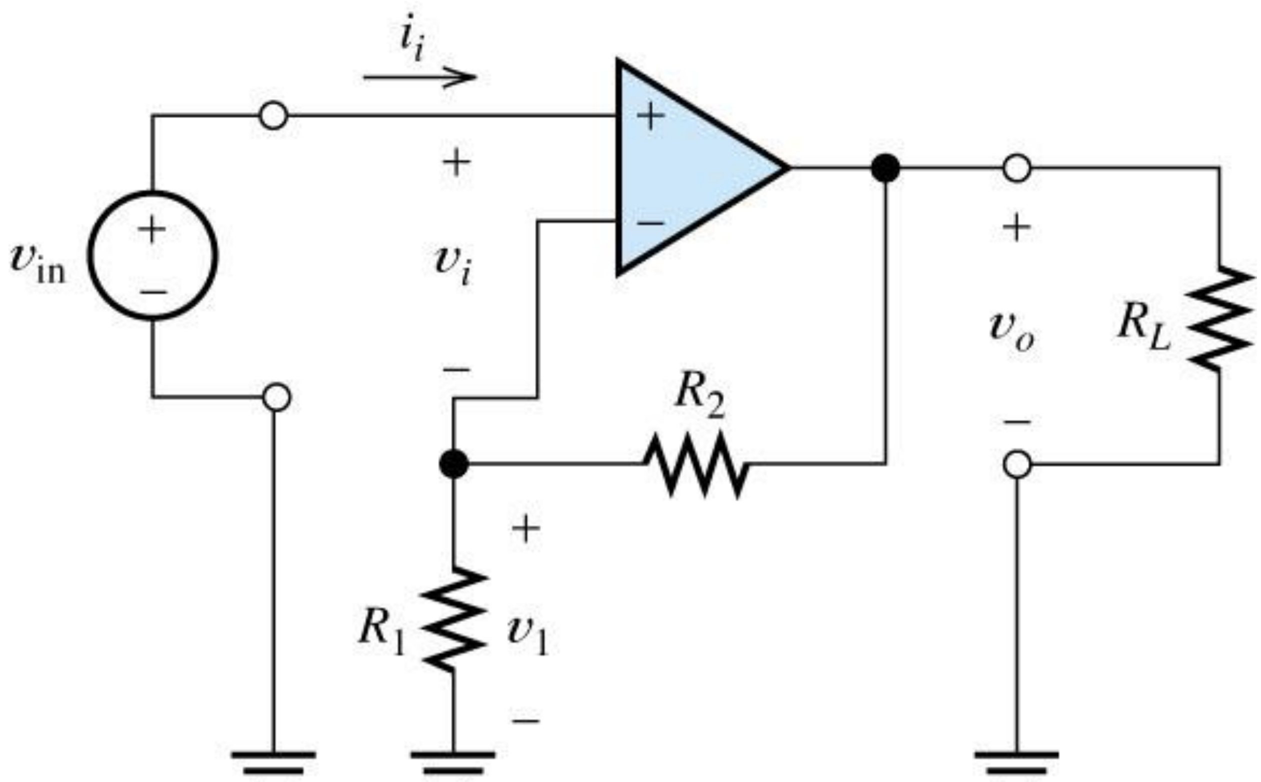
Table 9.1. Effects of Feedback[a]

Feedback Type	x_s	x_o	Gain Stabilized	Input Impedance	Output Impedance	Ideal Amplifier
Series voltage	v_s	v_o	$A_{vf} = \frac{A_v}{1 + A_v\beta}$	$R_i(1 + A_v\beta)$	$\frac{R_o}{1 + \beta A_{voc}}$	Voltage
Series current	v_s	i_o	$G_{mf} = \frac{G_m}{1 + G_m\beta}$	$R_i(1 + G_m\beta)$	$\boxed{R_o(1 + \beta G_{msc})}$	Transconductance
Parallel voltage	i_s	v_o	$R_{mf} = \frac{R_m}{1 + R_m\beta}$	$\frac{R_i}{1 + R_m\beta}$	$\frac{R_o}{1 + \beta R_{moc}}$	Transresistance
Parallel current	i_s	i_o	$A_{if} = \frac{A_i}{1 + A_i\beta}$	$\frac{R_i}{1 + A_i\beta}$	$R_o(1 + \beta A_{isc})$	Current

[a] Formulas given assume an ideal controlled source for the feedback network (as shown in Figure 9.14), zero source impedance for series feedback, and infinite source impedance for parallel feedback. Gains with subscripts sc and oc are for short-circuit and open-circuit loads, respectively. The gains A_v, G_m, R_m, and A_i are for the actual load.

Sp. 5 fra forberedelsen:

En ikke-inverterende forstærker som på figur 2.11 er bygget med R_1 = 10 kΩ og R_2 = 90 kΩ. Forstærkeren kan regnes ideel bortset fra en indgangsmodstand på R_{in} = 1 MΩ samt en endelig åbensløjfeforstærkning på A_{OL}.



Find bogstavudtryk og talværdi for α, β samt $\frac{\alpha}{\beta}$. Hvad bliver kravet til A_{OL} såfremt fejlen på lukketsløjfe forstærkningen $A_v = \frac{v_o}{v_{in}}$ ikke må overstige 100 ppm?