Ch. 31.2

Properties of feedback Amps

1) Gain desensitivity
2) Bandwidth extension
3) Reduction of non-linear dist.
4) input/output impedance control

$$A_{CL} = \frac{A_{OL}}{1 + A_{OL} \cdot \beta}$$

ideally $A_{CL} = \frac{1}{\beta}$ 58:12

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$A_{OL1} = 10^3$

$A_{OL2} = 2K$

$A_{OL_S} = 1K$

$A_{OLF} = 2k$

$$A_{CL}\Big|_{ideal} = 10 = \frac{1}{\beta}$$

$$A_{CL1} = \frac{10^3}{1 + 10^3/10} = \cancel{\frac{10^3}{1+10^4}} \approx \underline{10}$$

$$A_{CL2} = \frac{2\,10^3}{1 + \cdot 2K/10} \approx \underline{10}$$

31.2.1 Gain Desitivity

$$\frac{dA_{CL}}{dA_{OL}} = \frac{d}{dA_{OL}}\left(A_{OL}\left(1+\beta A_{OL}\right)^{-1}\right)$$

$$\frac{1}{1+\beta A_{OL}} + \frac{-A_{OL}}{\left(1+\beta A_{OL}\right)^2}\cdot \beta$$

2)

$$\frac{dA_{CL}}{dA_{OL}} = \frac{1+\beta A_{OL}}{(1+\beta A_{OL})^2} - \frac{\beta A_{OL}}{(1+\beta A_{OL})^2}$$

$$\frac{dA_{CL}}{dA_{OL}} = \frac{1}{(1+\beta A_{OL})^2} \qquad (31.8)$$

$$\frac{dA_{CL}}{A_{CL}} = \frac{dA_{OL}}{(1+\beta A_{OL})^2} \cdot \frac{1+\beta A_{OL}}{A_{OL}}$$

$$\frac{100\%}{1+\frac{1}{10}\cdot 10^3} \leftarrow \frac{dA_{CL}}{A_{CL}} = \frac{dA_{OL}}{A_{OL}} \cdot \frac{1}{1+\underbrace{\beta A_{OL}}_{\frac{1}{10}\cdot 10^3}}$$

$$\approx 1\%$$

$$dA_{OL} = 2K - 1K = 1K$$

$$A_{OL} = 1K$$

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3)

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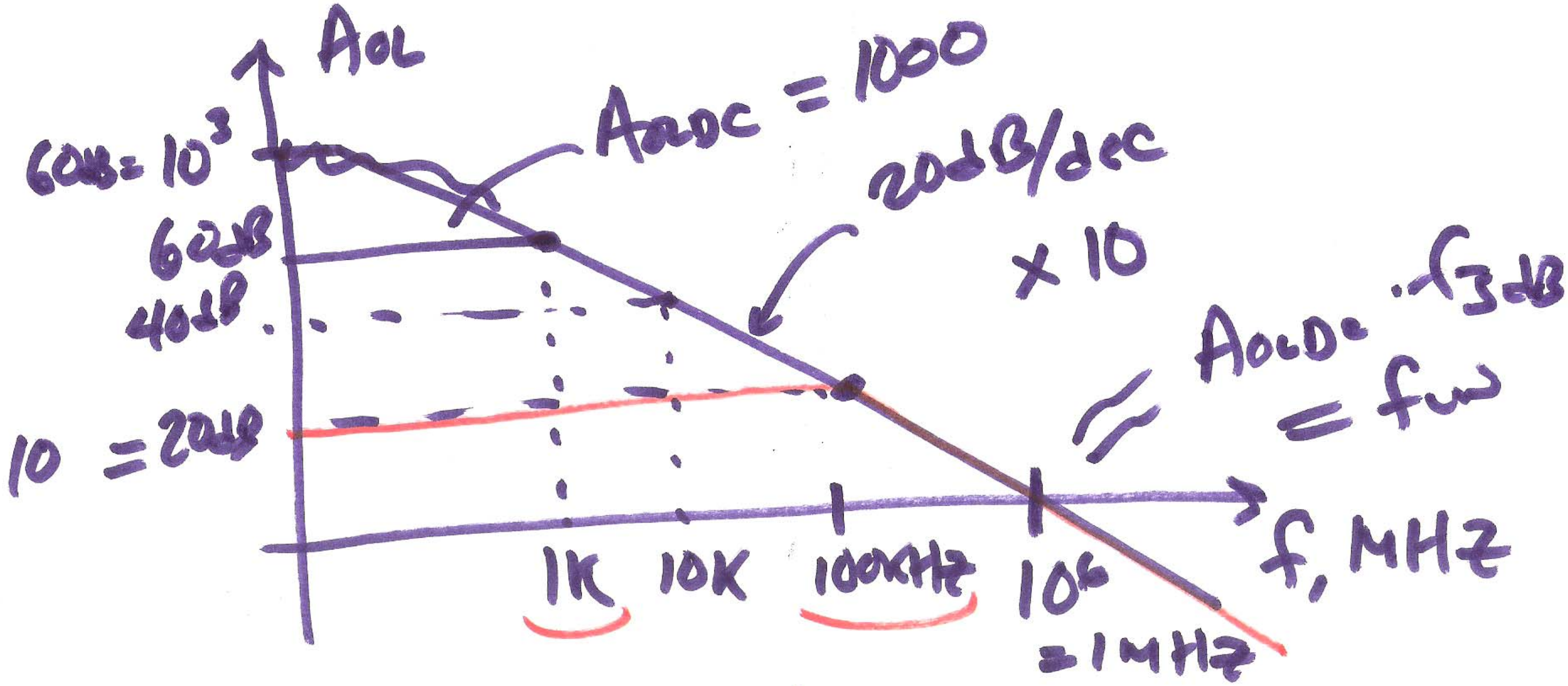

$$A_{OL}(f) = \frac{A_{OLDC}}{1 + j\frac{f}{f_{3dB}}}$$

$$|1| = \left|\frac{A_{OLDC}}{j\frac{f_{UN}}{1000K}}\right|$$

1K

$A_{OLDC} \cdot f_{3dB} = f_{UN}$

$$A_{OL}(f) = \frac{A_{OLDC}}{1 + j\frac{f}{f_{3dB}}}, \quad \frac{f}{f_{3dB}} = 1$$

$$A_{OL}(s) = \frac{A_{OLDC} \cdot \omega_H}{\omega_H + s}$$

$$\omega_H = 2\pi f_{3dB}$$

$$A_{OL} = \frac{A_{OLDC}}{1 + \frac{s}{\omega_H}} \quad 31.10$$

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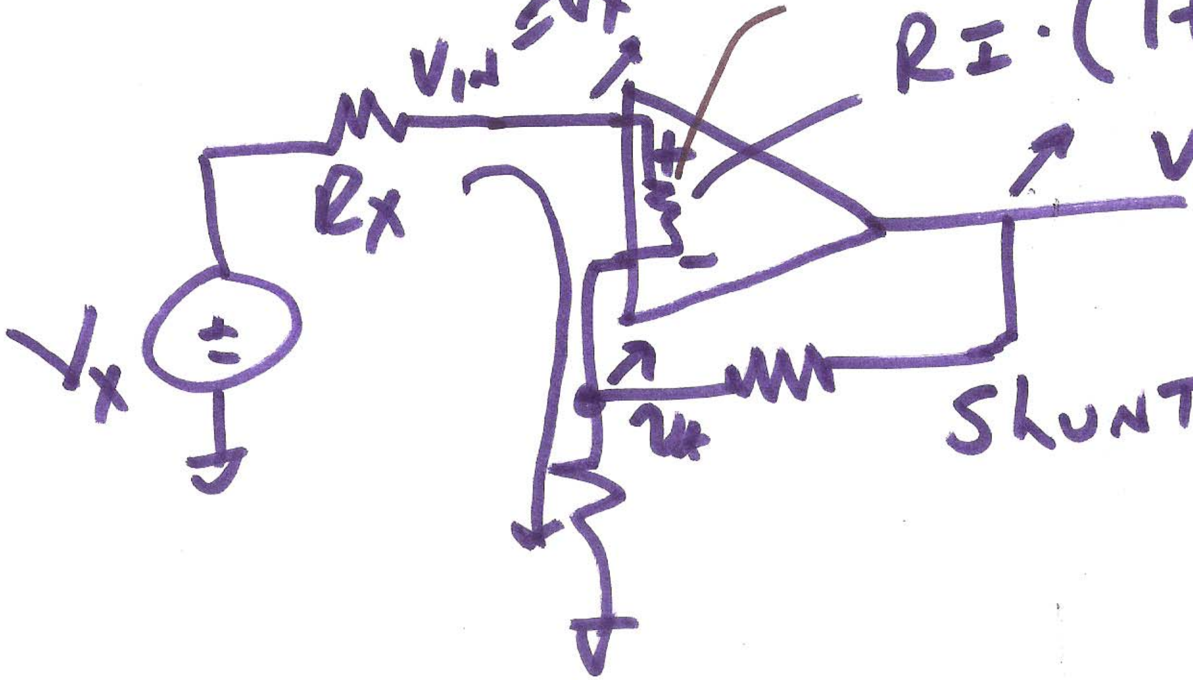
$$A_{CL}(f) = \underbrace{\frac{A_{OLDC}}{1 + j\frac{f}{f_{3dB}}}}_{A_{OL}(f)} \cdot \frac{1}{1 + \beta \underbrace{\frac{A_{OLDC}}{1 + j\frac{f}{f_{3dB}}}}_{A_{OL}(f)}}$$

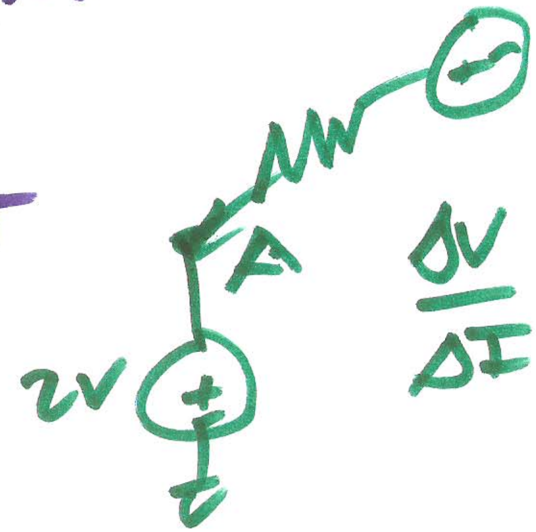
$$= \frac{A_{OLDC}}{1 + j\frac{f}{f_{3dB}} + \beta A_{OLDC}}$$

$$1 + \beta A_{OLDC} = \frac{f_{3dBCL}}{f_{3dB}}$$

$$f_{3dB}(1 + \beta A_{OLDC}) = f_{3dBCL}$$

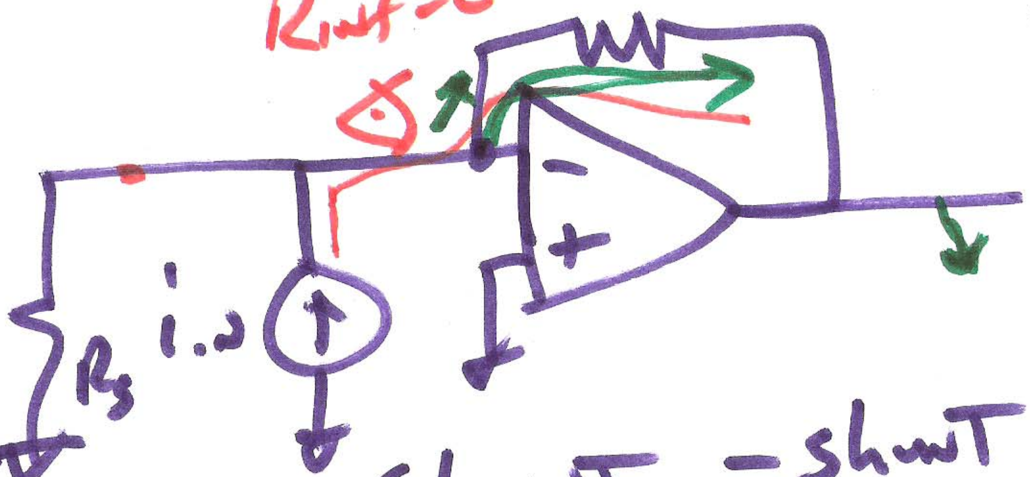
$R_I \cdot (1+\beta A_{OL}) = R_{inF}$





$\frac{\Delta V}{\Delta I} = R = 0$

Series



$R_{inf} = \frac{R_I}{1+\beta A_{OL}}$

Transimpedance $\frac{V_o}{I_{in}}$

GAIN = Ω

Shunt - shunt amp

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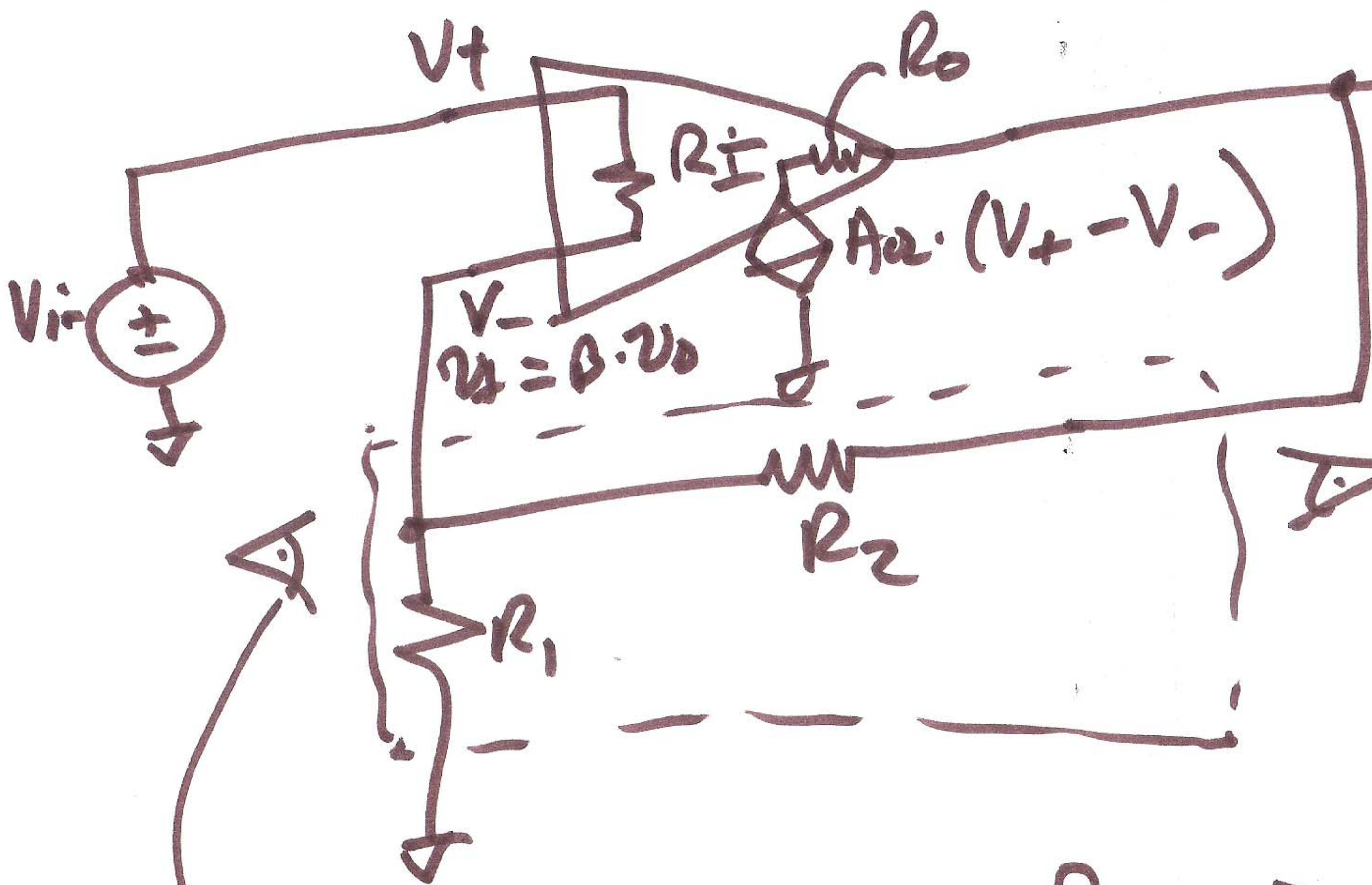

Shunt output (V)

$R_{of} >> R_o$

$= R_2 + R_1$

$R_o >> R_{If}$

$R_I >> R_1 || R_2 = R_{If}$

$R_{If} = R_1 || R_2$

Shunt input

$R_I >> R_{IF}$

Series input

$R_I << R_{IF}$

Not loading Amp with f.b.

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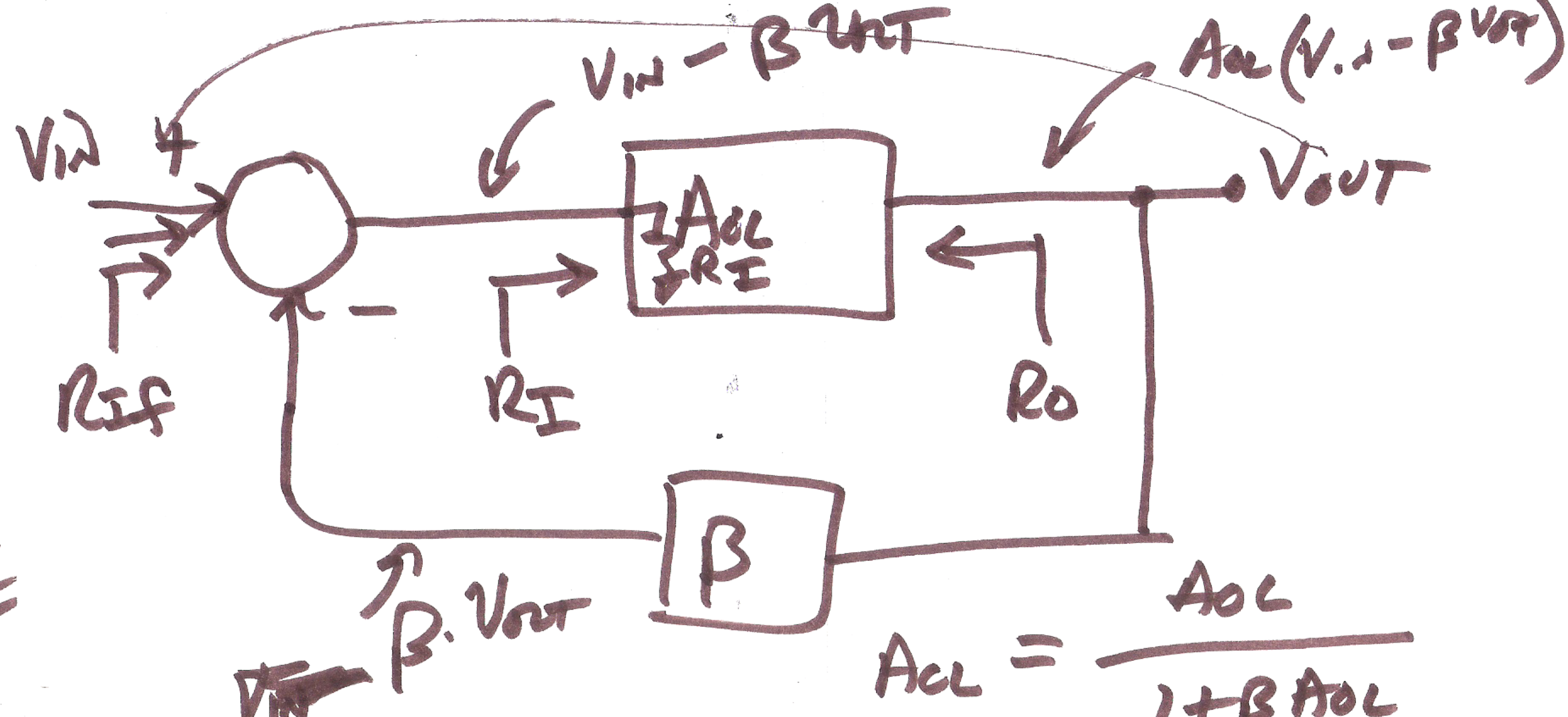

$$\frac{V_{IN}}{R_{IF}}$$

$$A_{CL} = \frac{A_{OL}}{1+\beta A_{OL}}$$

$$A_{CL} = \frac{V_{OUT}}{V_{IN}} = \frac{A_{OL}}{1+\beta A_{OL}}$$

$$V_{IN} = \frac{V_{OUT}(1+\beta A_{OL})}{A_{OL}}$$

$$\frac{V_{IN}}{R_I} \qquad \frac{V_{IN}}{R_{IF}}$$

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$$I = \frac{V_{IN} - \beta V_{OUT}}{R_I}, \quad V_{OUT} = V_{in}\left(\frac{A_{OL}}{1+\beta A_{OL}}\right)$$

$$\cancel{\frac{V_{IN} - \frac{\beta A_{OL} V_{in}}{(1+\beta A_{OL})}}{R_I}}$$

$$I = \frac{V_{IN} - \beta\left(V_{IN}\frac{A_{OL}}{1+\beta A_{OL}}\right)}{R_I}$$

$$R_{IF} = \frac{V_{in} \qquad R_I}{V_{in}\left(\frac{1+\beta A_{OL} \cancel{-\beta A_{OL}}}{1+\beta A_{OL}}\right)}$$

$$R_{IF} = R_I\left(1+\beta A_{OL}\right)$$

$$I_I = \frac{V_{IN} - \beta V_{OUT}}{R_I}$$

$$R_{IF} = \frac{V_{IN}}{I_I}$$

$$V_{IN} \cdot \frac{A_{OL}}{1+\beta A_{OL}} = V_{OUT}$$

$$I_I = \frac{1}{R_I}\left(V_{IN} - \frac{\beta V_{IN} A_{OL}}{1+\beta A_{OL}}\right)$$

$$R_I(1+\beta A_{OL}) = R_{IF} = \frac{\cancel{V_{IN}}}{\frac{\cancel{V_{IN}}}{R_I}\left(1 - \frac{\beta A_{OL}}{1+\beta A_{OL}}\right)}$$

$$= \frac{R_I}{\frac{1+\beta A_{OL}}{1+\beta A_{OL}} - \frac{\beta A_{OL}}{1+\beta A_{OL}}}$$

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