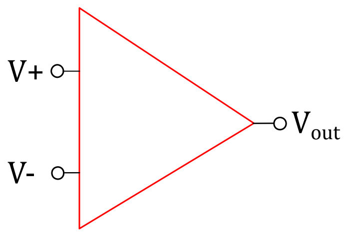
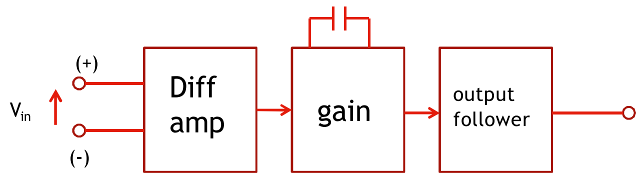
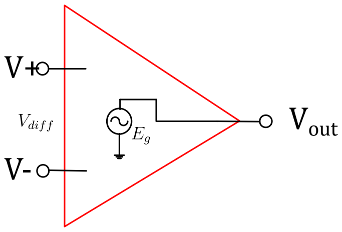
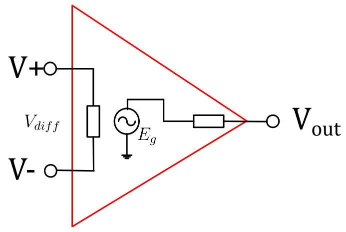




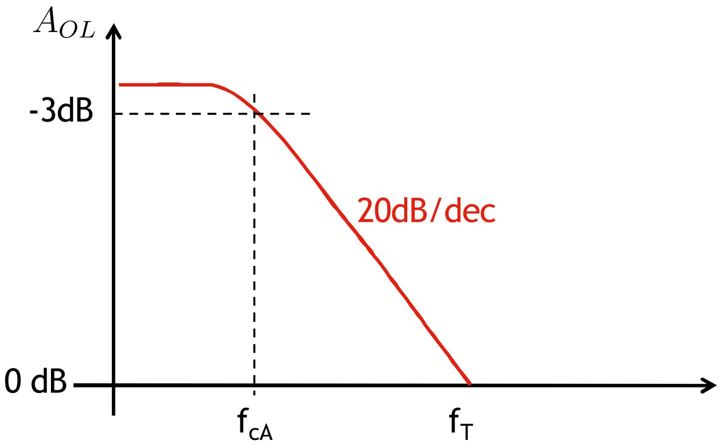


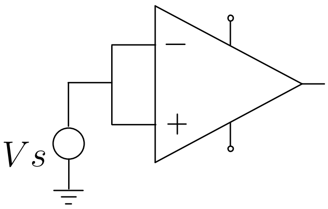


$$E_g = A_{OL} \cdot V_{diff} = A_{OL} \cdot (V(+) - V(-))$$

$$A_{OL} = \infty$$
$$R_{in} = \infty$$
$$R_{out} = 0$$
$$f_T = \infty$$
$$CMRR = \infty$$
$$SR = \infty$$

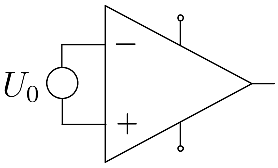
$$A_{OL} \approx 100dB$$
$$R_{in} \approx 1M\Omega - 1T\Omega$$
$$R_{out} \approx 10\Omega - 1k\Omega$$
$$f_T \approx 1MHz - 500MHz$$
$$CMRR \approx 100dB$$
$$SR \approx 1 - 3000\frac{V}{\mu s}$$





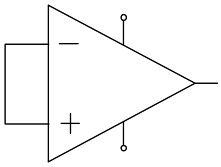
$$V = \frac{Vs}{CMRR}$$

$I_{in(bias)}$
$I_{in(off)}$
$V_{in(off)}$



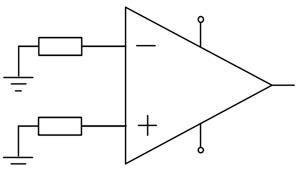
$U_{out} = 0$

$U_0 = 0$



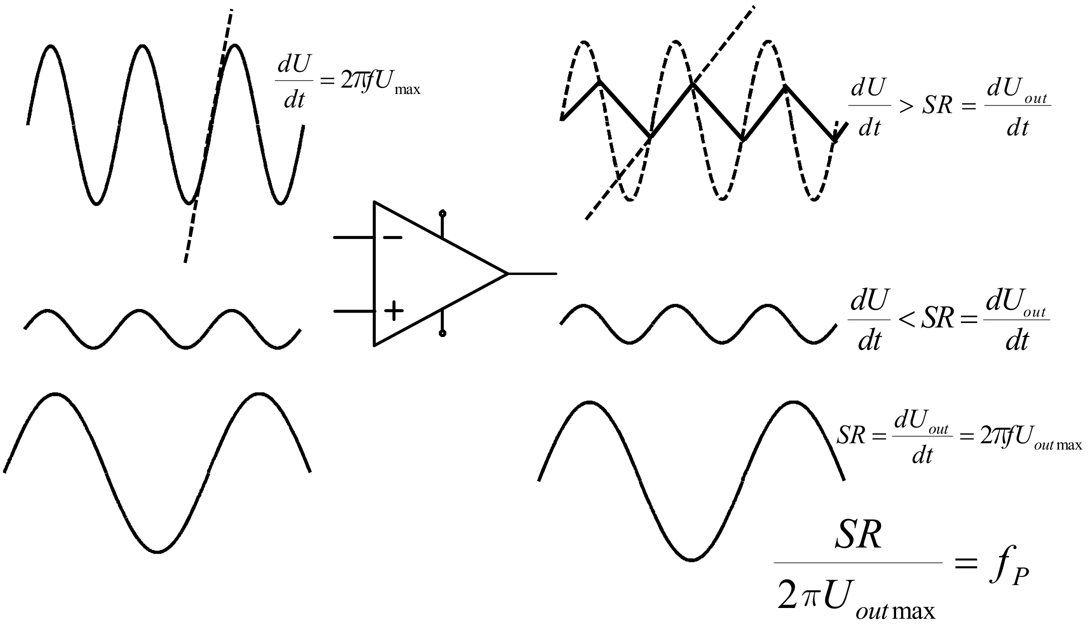
$U_{out} = A_V \cdot V_{in(off)}$

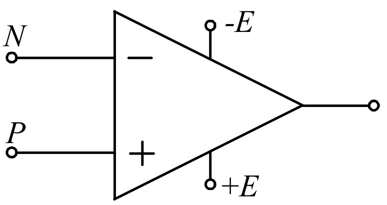
$V_R = I_{B2}R$

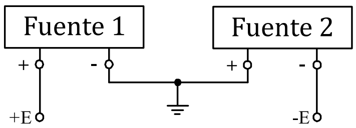


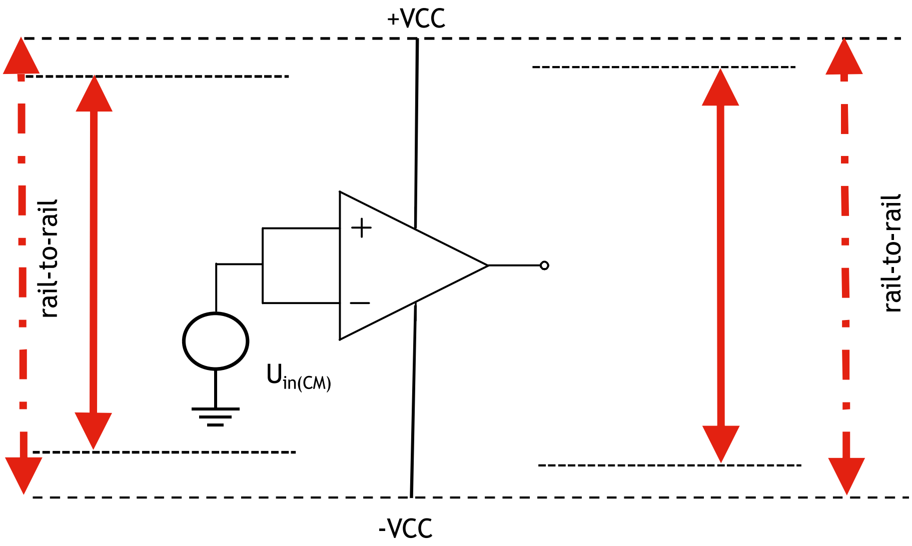
$$U_{out} = (I_{B1} - I_{B2})\, RA_V = I_{bias}RA_V$$

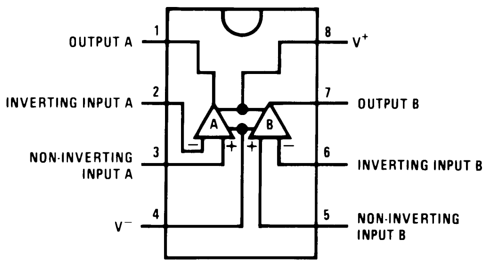
$V_R = I_{B1}R$


$\frac{dU}{dt} = 2\pi f U_{\max}$
$\frac{dU}{dt} > SR = \frac{dU_{out}}{dt}$
$\frac{dU}{dt} < SR = \frac{dU_{out}}{dt}$
$SR = \frac{dU_{out}}{dt} = 2\pi f U_{out\,\max}$
$\frac{SR}{2\pi U_{out\,\max}} = f_P$

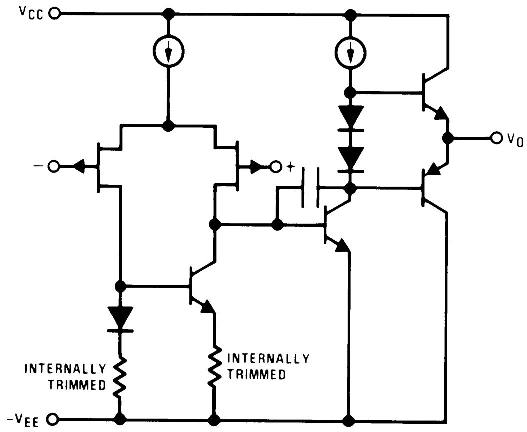

N
P
-E
+E


Fuente 1
Fuente 2
+E
-E


+VCC
-VCC
rail-to-rail
rail-to-rail
$U_{in(CM)}$



PDIP/SOIC Package (Top View)



Absolute Maximum Ratings [1][2]

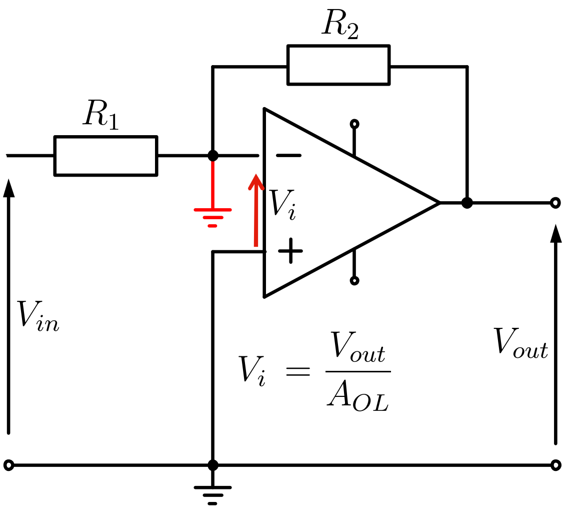
Supply Voltage	±18V
Power Dissipation [3]	[4]
Operating Temperature Range	0°C to +70°C
$T_{j(MAX)}$	150°C
Differential Input Voltage	±30V
Input Voltage Range [5]	±15V
Output Short Circuit Duration	Continuous
Storage Temperature Range	−65°C to +150°C
Lead Temp. (Soldering, 10 seconds)	260°C
ESD rating to be determined.	

DC Electrical Characteristics [1]

Symbol	Parameter	Conditions	TL082C			Units
			Min	Typ	Max	
V_{OS}	Input Offset Voltage	R_S = 10 kΩ, T_A = 25°C		5	15	mV
		Over Temperature			20	mV
$\Delta V_{OS}/\Delta T$	Average TC of Input Offset Voltage	R_S = 10 kΩ		10		µV/°C
I_{OS}	Input Offset Current	T_j = 25°C, [1] [2]		25	200	pA
		$T_j \leq$ 70°C			4	nA
I_B	Input Bias Current	T_j = 25°C, [1] [2]		50	400	pA
		$T_j \leq$ 70°C			8	nA
R_{IN}	Input Resistance	T_j = 25°C		10^{12}		Ω
A_{VOL}	Large Signal Voltage Gain	V_S = ±15V, T_A = 25°C, V_O = ±10V, R_L = 2 kΩ	25	100		V/mV
		Over Temperature	15			V/mV
V_O	Output Voltage Swing	V_S = ±15V, R_L = 10 kΩ	±12	±13.5		V
V_{CM}	Input Common-Mode Voltage Range	V_S = ±15V	±11	+15		V
				−12		V
CMRR	Common-Mode Rejection Ratio	$R_S \leq$ 10 kΩ	70	100		dB
PSRR	Supply Voltage Rejection Ratio	[3]	70	100		dB
I_S	Supply Current			3.6	5.6	mA

AC Electrical Characteristics

Symbol	Parameter	Conditions	TL082C			Units
			Min	Typ	Max	
	Amplifier to Amplifier Coupling	T_A = 25°C, f = 1Hz-20 kHz (Input Referred)		−120		dB
SR	Slew Rate	V_S = ±15V, T_A = 25°C	8	13		V/µs
GBW	Gain Bandwidth Product	V_S = ±15V, T_A = 25°C		4		MHz
e_n	Equivalent Input Noise Voltage	T_A = 25°C, R_S = 100Ω, f = 1000 Hz		25		nV/√Hz
i_n	Equivalent Input Noise Current	T_j = 25°C, f = 1000 Hz		0.01		pA/√Hz
THD	Total Harmonic Distortion	A_V = +10, R_L = 10k, V_O = 20 Vp − p, BW = 20 Hz−20 kHz		<0.02		%



$$A_{OL} = \infty \Rightarrow V_i = 0 \Rightarrow V(+) = V(-)$$

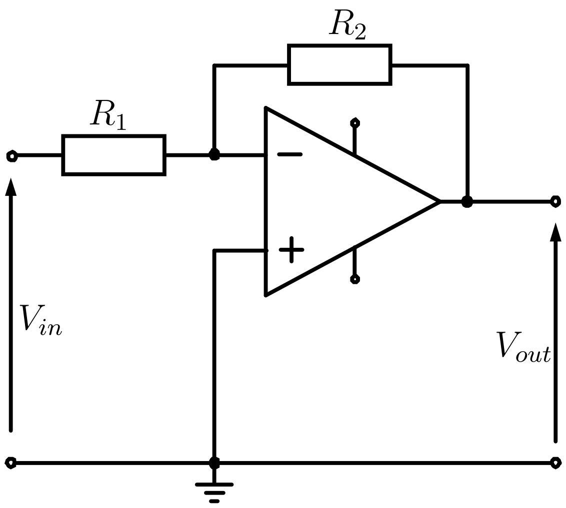
$$R_{in} = \infty \Rightarrow I_{in} = 0$$

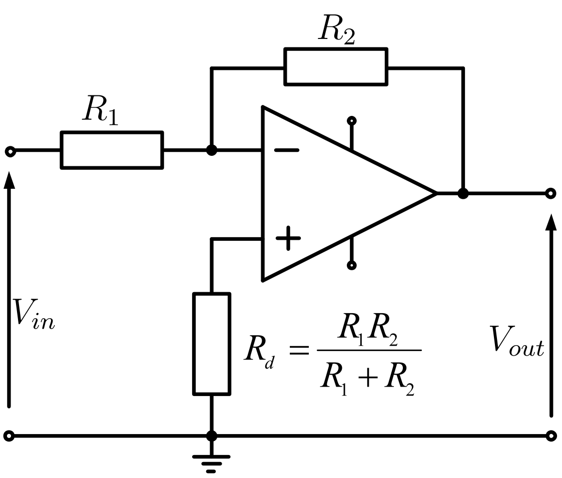
$$I_{in} = \frac{V_{in}}{R_1} \qquad I_{out} = \frac{V_{out}}{R_2}$$

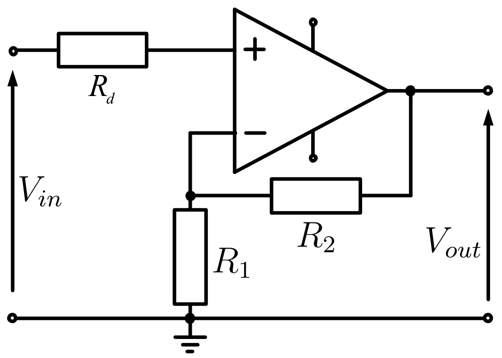
$$I_{in} = -I_{out}$$

$$\frac{V_{in}}{R_1} = -\frac{V_{out}}{R_2}$$

$$A_V = \frac{V_{out}}{V_{in}} = -\frac{R_2}{R_1}$$





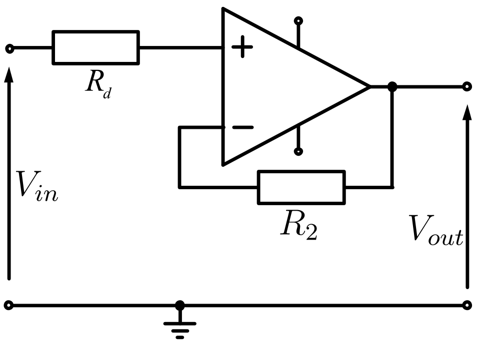


$$A_{OL} = \infty \Rightarrow V_{in} = 0 \Rightarrow V(+) = V(-)$$

$$R_{in} = \infty \Rightarrow I_{in} = 0$$

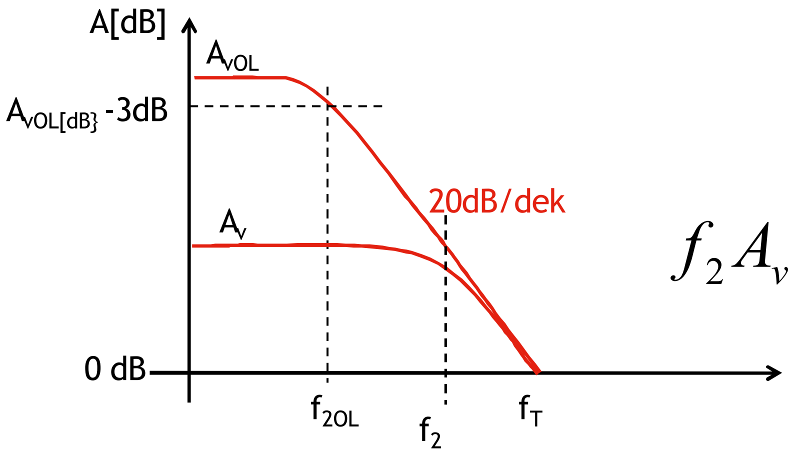
$$V_{in} = \frac{R_1}{R_1 + R_2} V_{out} \Rightarrow A_V = \frac{V_{out}}{V_{in}} = 1 + \frac{R_2}{R_1}$$

$$R_d = \frac{R_1 R_2}{R_1 + R_2}$$

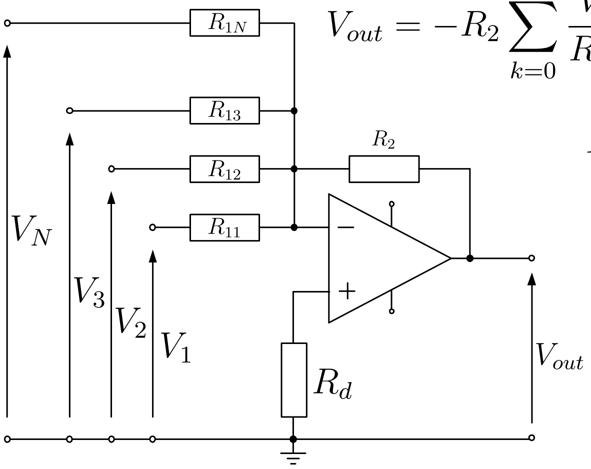


$$A_V = \frac{V_{out}}{V_{in}} = 1 + \frac{R_2}{R_1}$$

$$R_1 = \infty \Rightarrow A_V = 1$$

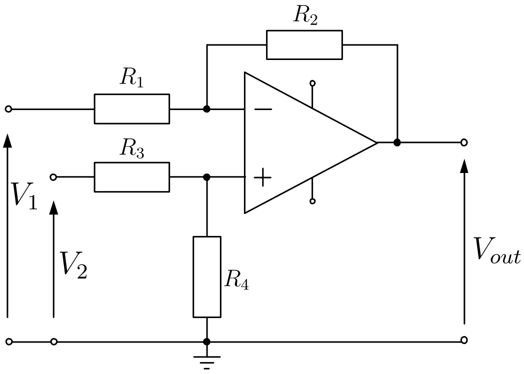


$$f_2 A_v = f_T$$



$$V_{out} = -R_2 \sum_{k=0}^{N} \frac{V_k}{R_{1k}} = -R_2 \left(\frac{V_1}{R_{11}} + \frac{V_2}{R_{12}} + \frac{V_3}{R_{13}} + ... + \frac{V_N}{R_{1N}} \right)$$

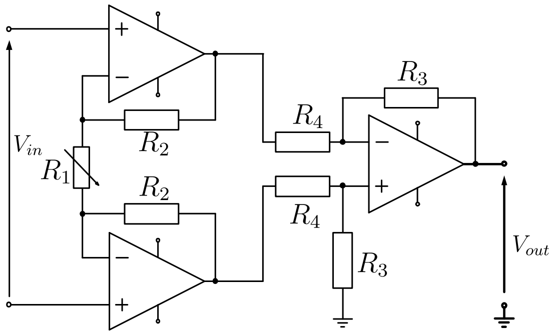
$$R_d = R_2 || R_{11} || R_{12} || R_{13} || ... || R_{1N}$$



$$V_{out} = V_2 \frac{R_1 + R_2}{R_3 + R_4} \frac{R_4}{R_1} - V_1 \frac{R_2}{R_1}$$

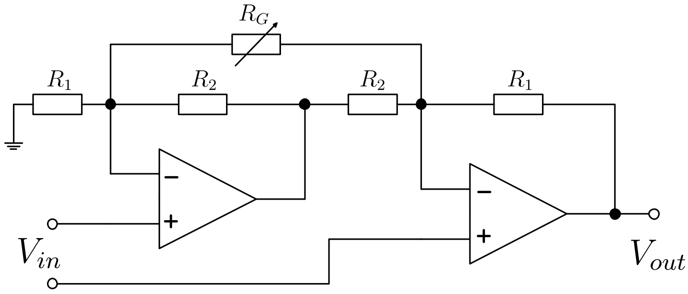
$$R_1 = R_3 \ \& \ R_2 = R_4$$

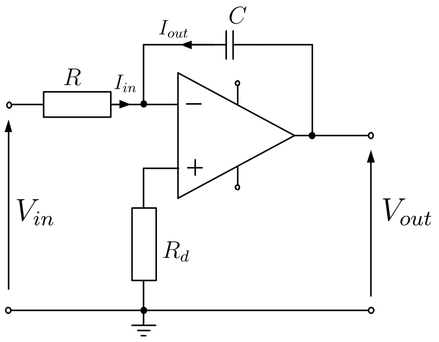
$$V_{out} = \frac{R_2}{R_1} (V_2 - V_1)$$



$$V_{out} = \left(1 + 2\frac{R_2}{R_1} \right) \frac{R_4}{R_3} V_{in}$$

$$V_{out} = \left(1 + \frac{R_1}{R_2} + 2\frac{R_1}{R_G} \right) V_{in}$$



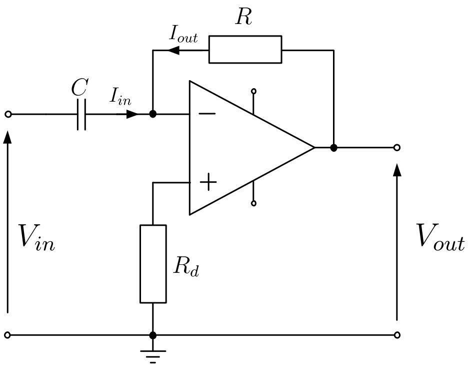


$$I_{in} = \frac{V_{in}(t)}{R}$$

$$I_{out} = I_C = C\frac{dV_{out}}{dt}$$

$$I_{in} = -I_{out} \qquad R_d = R$$

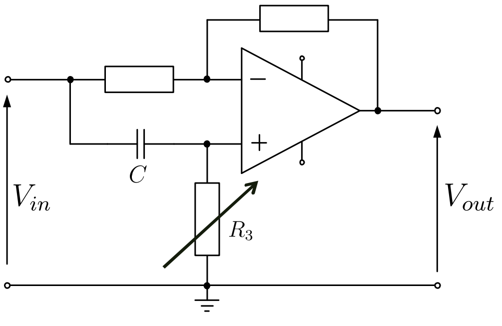
$$V_{out} = -\frac{1}{RC}\int V_{in(t)}dt + U_0$$



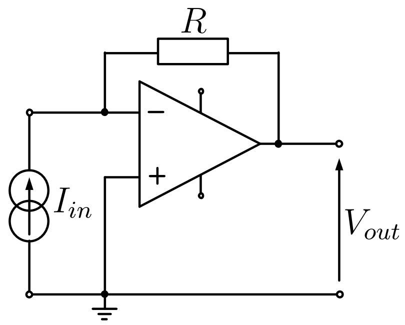
$$I_{in} = I_C = C\frac{dV_{in}(t)}{dt} \qquad I_{out} = \frac{V_{out}(t)}{R}$$

$$I_{in} = -I_{out}$$

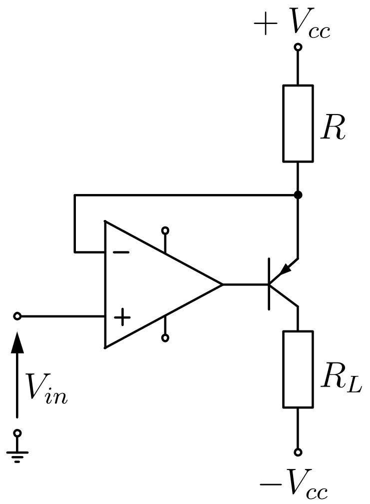
$$V_{out} = -RC\frac{dV_{in}(t)}{dt}$$



$$\frac{V_{out}}{V_{in}} = \frac{1 - sCR_3}{1 + sCR_3}$$



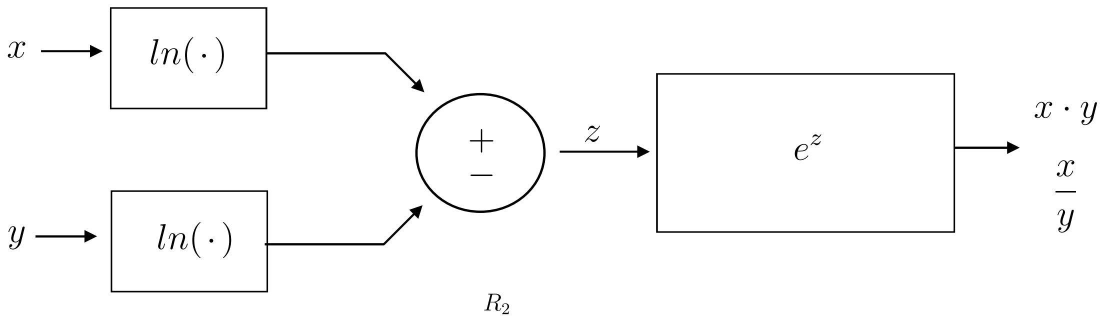
$$V_{out} = R \cdot I_{in}$$

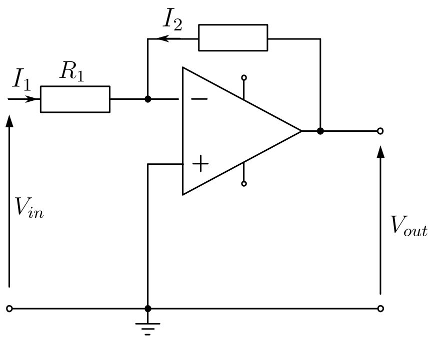


$$I_{out} = \frac{V_{cc} - V_{in}}{R}$$

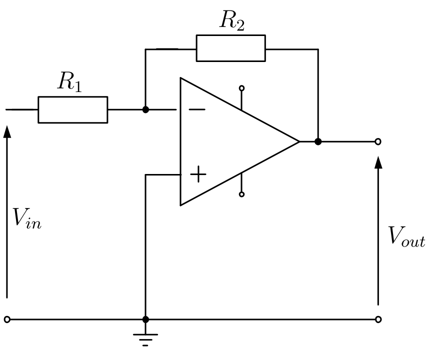
$$ln\,(x \cdot y) = ln(x) + ln(y) \qquad\qquad ln\left(\frac{x}{y}\right) = ln(x) - ln(y)$$

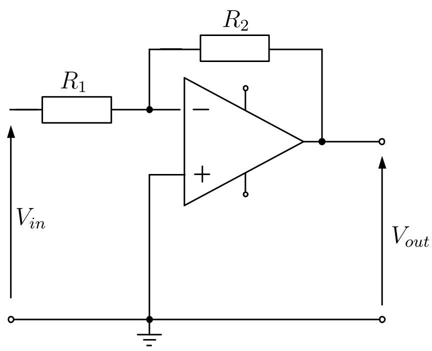
$$e^{ln(x \cdot y)} = x \cdot y \qquad\qquad e^{ln\left(\frac{x}{y}\right)} = \frac{x}{y}$$





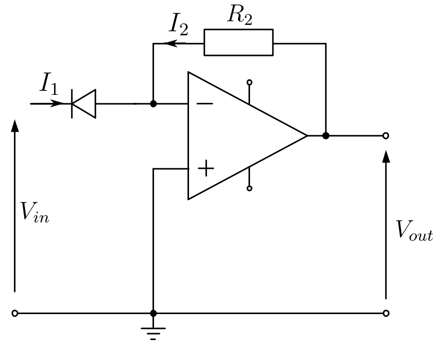
$$I_2 = f\,(V_{out})$$
$$I_1 = f\,(V_{in})$$

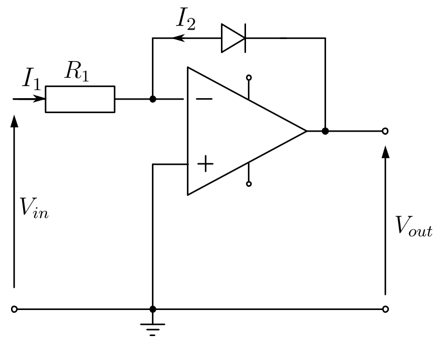




$$I_1 = f\,(V_{in}) = -\frac{V_{out}}{R_2} \Rightarrow V_{out} = R_2 \cdot f\,(V_{in})$$

$$I_1 = -\frac{V_{in}}{R_1} = f\,(-V_{out}) \Rightarrow V_{out} = -f^{-1}\left(\frac{V_{in}}{R_1}\right)$$





$I_1 = -I_2$

$I_1 = -I_s e^{-\frac{V_{in}}{\varphi_T}}$

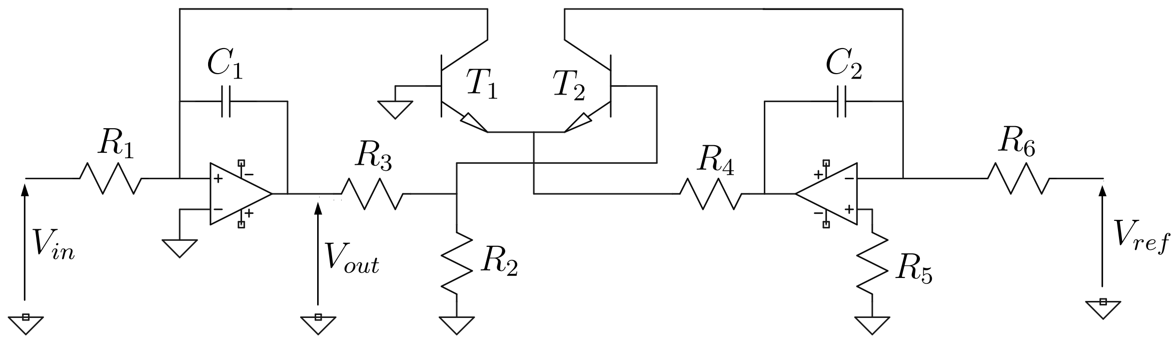
$V_{out} = I_s \cdot R_2 \cdot e^{-\frac{V_{in}}{\varphi_T}}$

$\varphi_T = \frac{kT}{q} \approx 26mV$

$I_2 = -I_s e^{-\frac{V_{in}}{\varphi_T}}$

$I_1 = \frac{V_{in}}{R_1}$

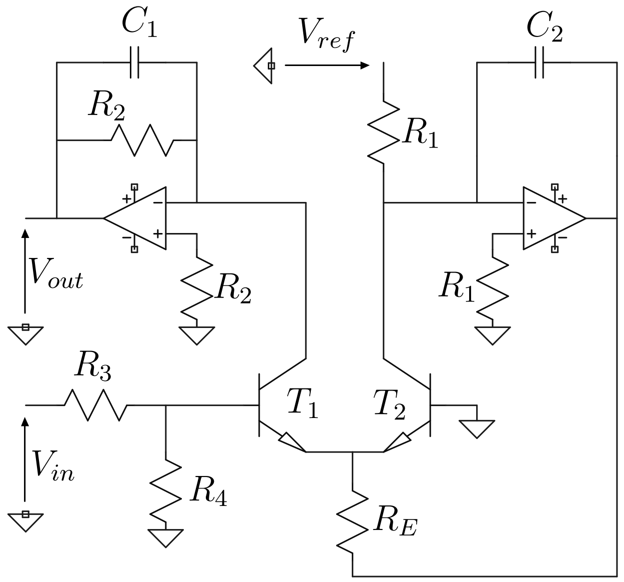
$V_{out} = -\varphi_T \cdot ln\left(\frac{V_{in}}{R_1 \cdot I_s}\right)$



$$V_{out} = -\varphi_T \left(1 + \frac{R_3}{R_2}\right) ln\left(\frac{R_5}{R_1}\frac{V_{in}}{V_{ref}}\right)$$

$$V_{out} = -log\left(V_{in}\right)$$

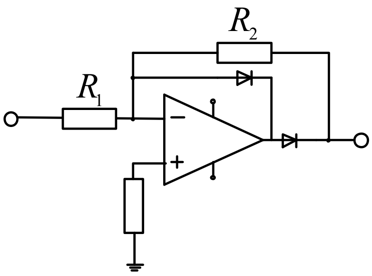
$$\varphi_T = 26mV \quad \frac{R_3}{R_2} = 15.7 \quad \frac{R_5}{V_{ref}R_1} = 1$$

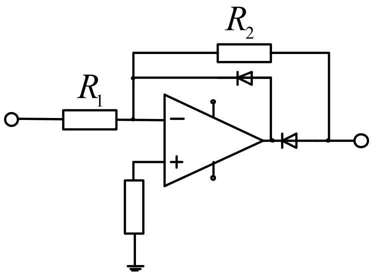


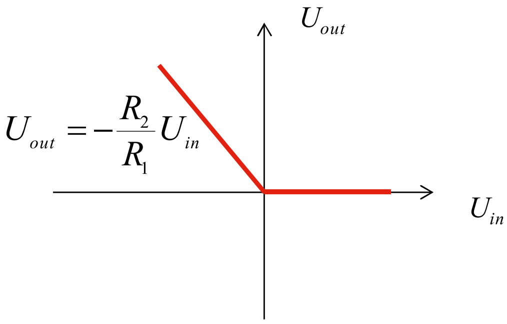
$$V_{out} = V_{ref}\frac{R_2}{R_1}e^{\frac{V_{in}}{\varphi_T}\frac{R_3}{R_3+R_4}}$$

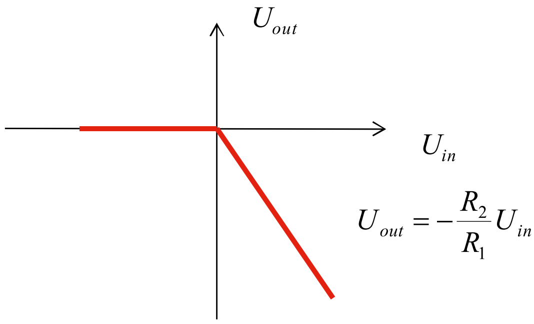
$$\varphi_T = 26mV \qquad \frac{V_{ref}R_2}{R_1} = 1 \qquad \frac{R_3}{R_4} = 15.7$$

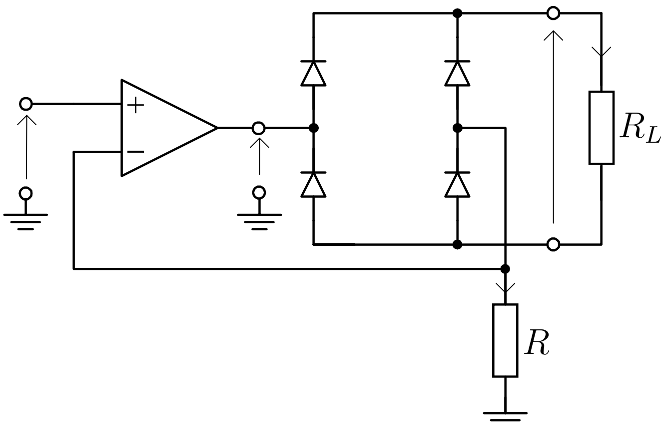
$$V_{out} = 10^{V_{in}}$$



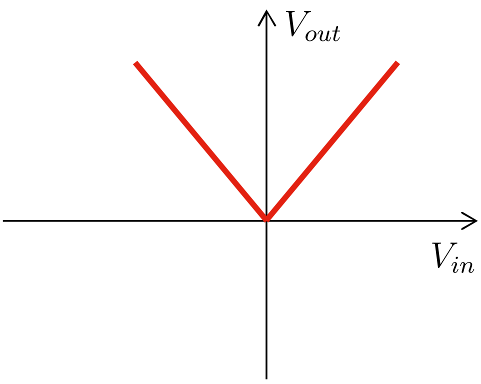


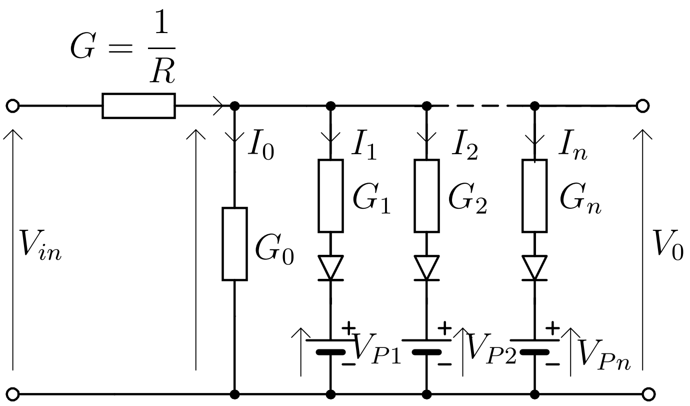


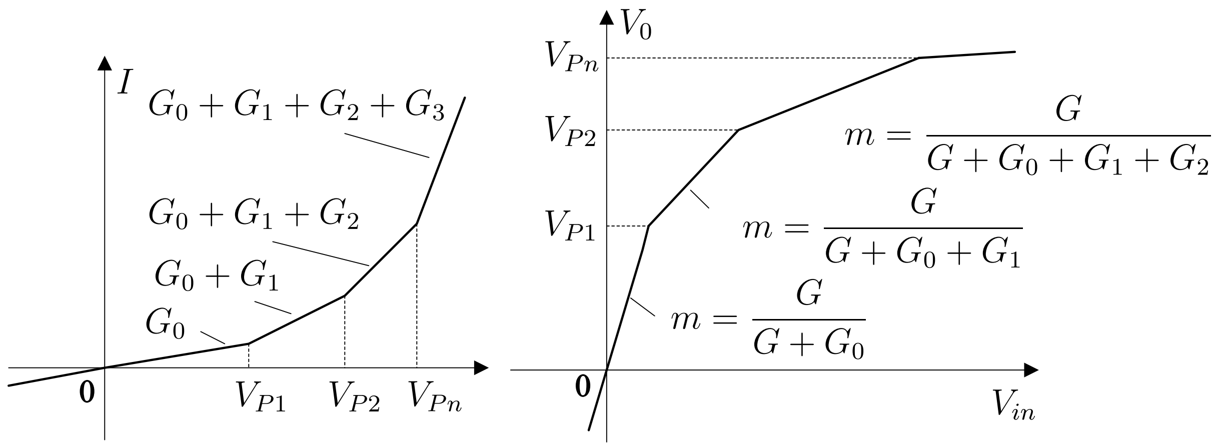


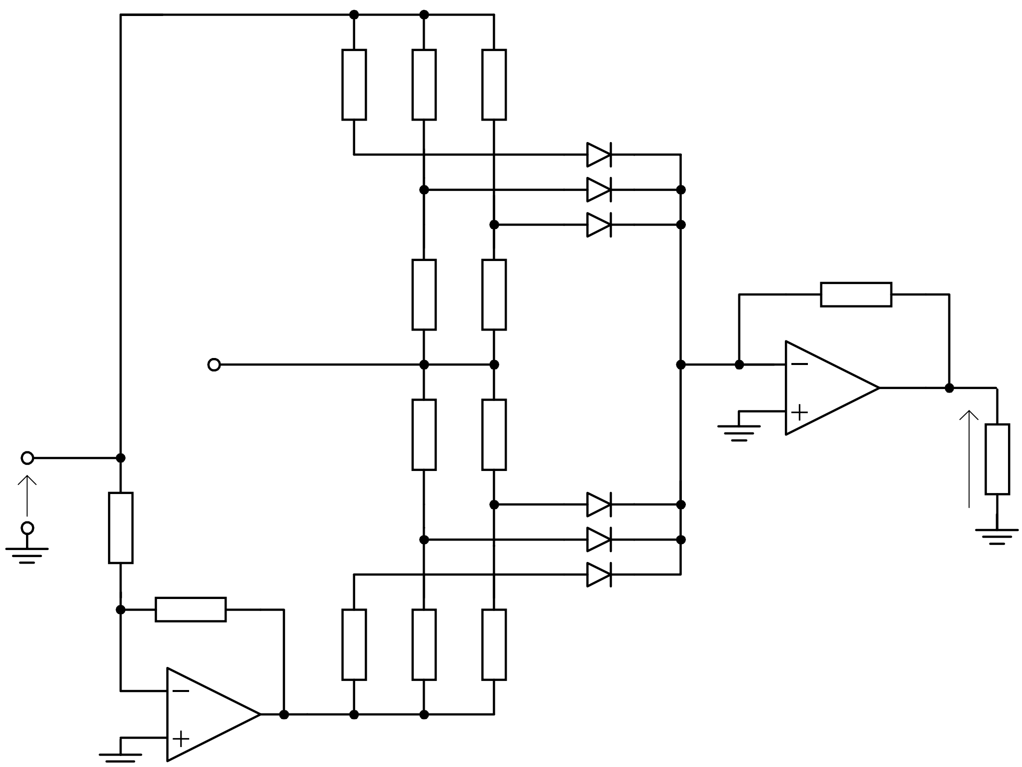


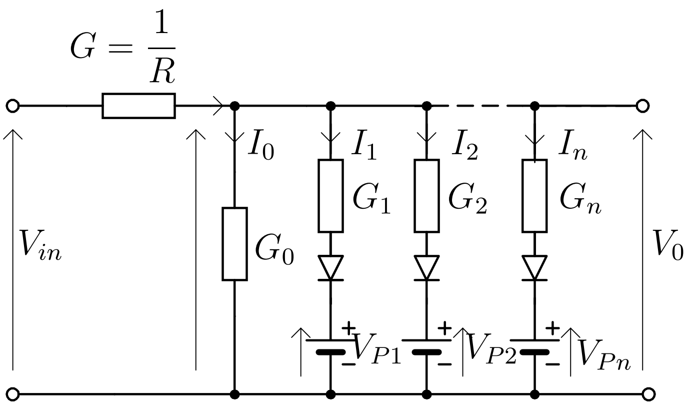
$$V_{out} = \frac{R_L}{R_1} |V_{in}|$$

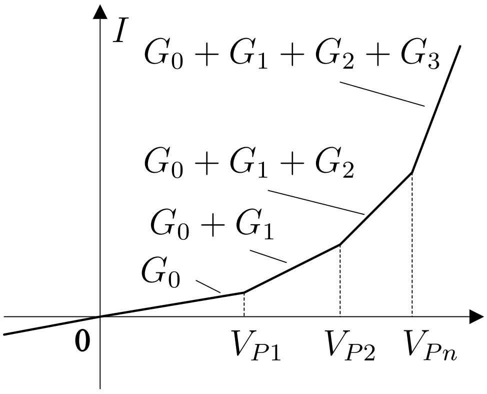


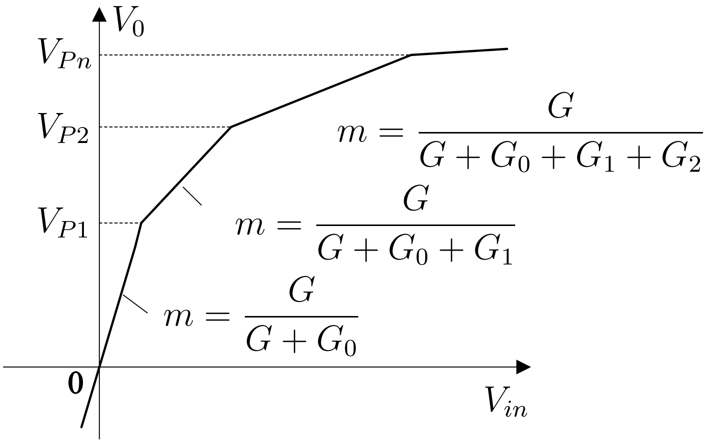

$G = \dfrac{1}{R}$
I_0
I_1
I_2
I_n
G_1
G_2
G_n
V_{in}
G_0
V_0
V_{P1}
V_{P2}
V_{Pn}

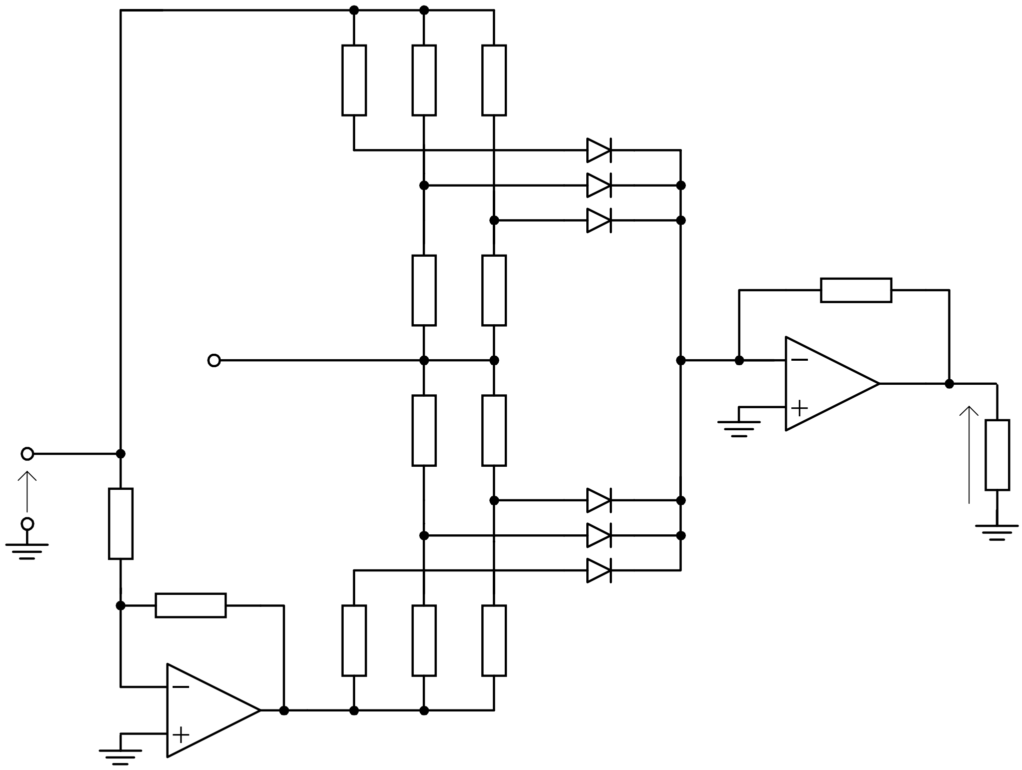

I
$G_0 + G_1 + G_2 + G_3$
$G_0 + G_1 + G_2$
$G_0 + G_1$
G_0
0
V_{P1}
V_{P2}
V_{Pn}
V_0
V_{Pn}
V_{P2}
V_{P1}
$m = \dfrac{G}{G + G_0 + G_1 + G_2}$
$m = \dfrac{G}{G + G_0 + G_1}$
$m = \dfrac{G}{G + G_0}$
0
V_{in}

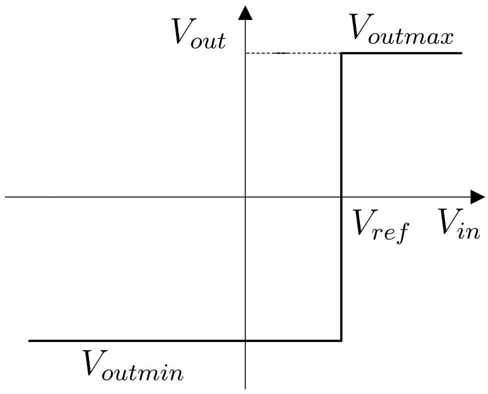


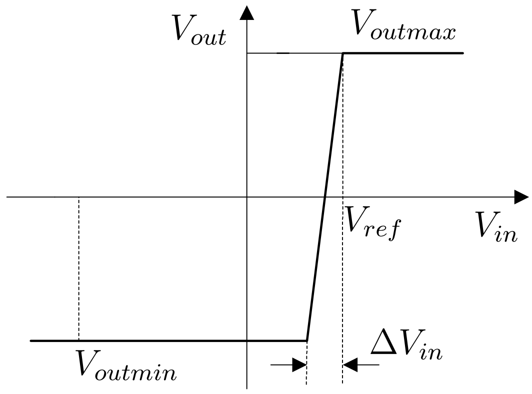

$G = \frac{1}{R}$
I_0
I_1
I_2
I_n
G_1
G_2
G_n
V_{in}
G_0
V_0
V_{P1}
V_{P2}
V_{Pn}


I
$G_0 + G_1 + G_2 + G_3$
$G_0 + G_1 + G_2$
$G_0 + G_1$
G_0
0
V_{P1}
V_{P2}
V_{Pn}

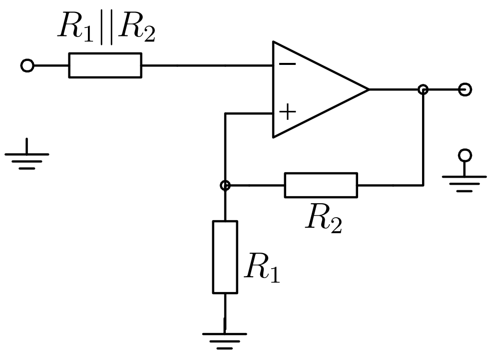

V_0
V_{Pn}
V_{P2}
V_{P1}
$m = \frac{G}{G + G_0 + G_1 + G_2}$
$m = \frac{G}{G + G_0 + G_1}$
$m = \frac{G}{G + G_0}$
0
V_{in}

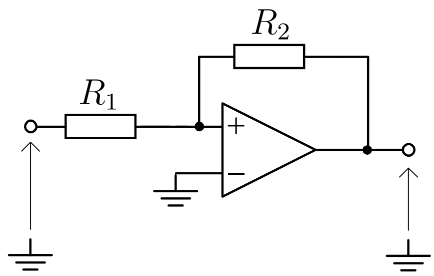






$$V_{out} = \begin{cases} V_{outmin} & para \quad V_{in} < V_{ref} \\ 0 & para \quad V_{in} = V_{ref} \\ V_{outmax} & para \quad V_{in} > V_{ref} \end{cases}$$





$$V_{inmax} = \frac{R_1}{R_1 + R_2} V_{outmax}$$

$$V_{inmin} = \frac{R_1}{R_1 + R_2} V_{outmin}$$

$$V_{inmax} = -\frac{R_1}{R_2} V_{outmax}$$

$$V_{inmin} = -\frac{R_1}{R_2} V_{outmin}$$