

圖12.23 求差動放大器的 R_{in}

由上式可知，高輸入阻抗與高電壓增益之間，存在著矛盾，亦即在高電壓增益的要求下，輸入阻抗將會不夠高，可改良如下。

二、改良型差動放大器

改良後的差動放大器如下圖，又稱儀表差動放大器。

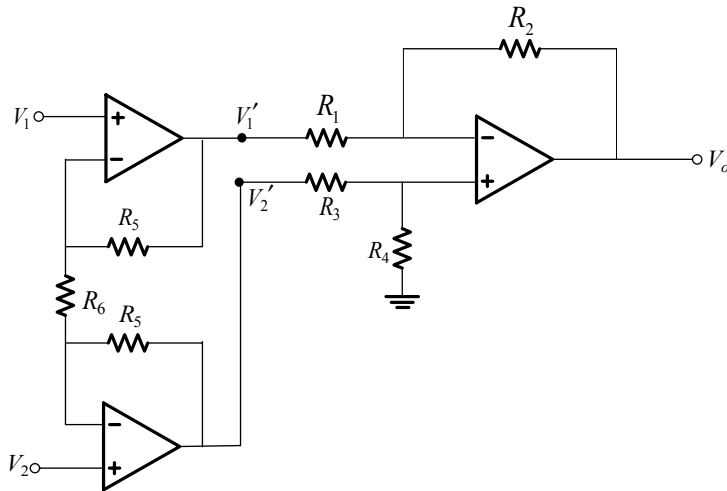


圖12.24 改良型的差動放大器

$$V_o = -\frac{R_2}{R_1} V_1' + \frac{R_4}{R_3 + R_4} \left(1 + \frac{R_2}{R_1} \right) V_2' \dots\dots\dots(12.27)$$

$$\text{其中 } V_1' = \left(1 + \frac{R_5}{R_6} \right) V_1 - \frac{R_5}{R_6} V_2 \dots\dots\dots(12.28)$$

$$V_2' = \left(1 + \frac{R_5}{R_6}\right)V_2 - \frac{R_5}{R_6}V_1 \quad \dots\dots\dots(12.29)$$

$$V_o = \left(-\frac{R_2}{R_1} - \frac{R_2 R_5}{R_1 R_6} - \frac{R_1 + R_2}{R_1} \frac{R_4}{R_3 + R_4} \frac{R_5}{R_6}\right)V_1 + \left[\frac{R_2}{R_1} \frac{R_5}{R_6} + \frac{R_1 + R_2}{R_1} \frac{R_4}{R_3 + R_4} \left(1 + \frac{R_5}{R_6}\right)\right]V_2 \quad \dots\dots\dots(12.30)$$

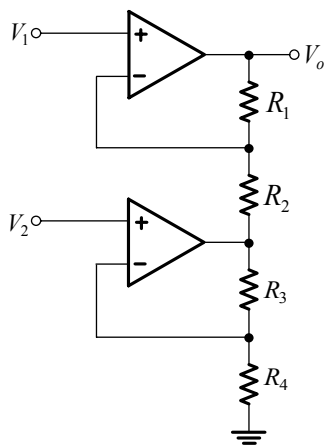
若 $R_1 = R_3$ 且 $R_2 = R_4$ ，則上式可簡化為：

$$V_o = \frac{R_2}{R_1} \left(1 + \frac{2R_5}{R_6}\right)(V_2 - V_1)$$

這種改良後的差動放大器，其輸入阻抗理論上為無窮大。

• 範題 10 •

如圖所示電路，求 V_o 。（理想OPA）。



【解析】

重疊定理

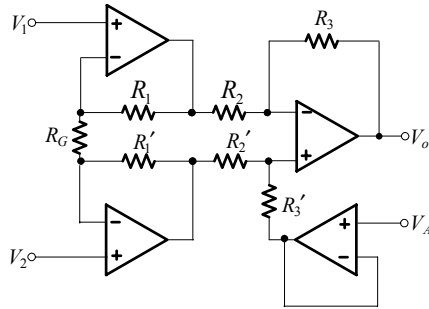
$$V_{o1} = V_2 \left(1 + \frac{R_3}{R_4}\right)$$

$$V_o = \left(1 + \frac{R_1}{R_2}\right)V_1 + V_2 \left(1 + \frac{R_3}{R_4}\right) \left(-\frac{R_1}{R_2}\right)$$

$$= \left(1 + \frac{R_1}{R_2}\right)V_1 - \frac{R_1}{R_2} \left(1 + \frac{R_3}{R_4}\right)V_2$$

• 範題 11 •

若 $R_1 = R'_1$, $R_2 = R'_2$, $R_3 = R'_3$, 求 $V_o = ?$

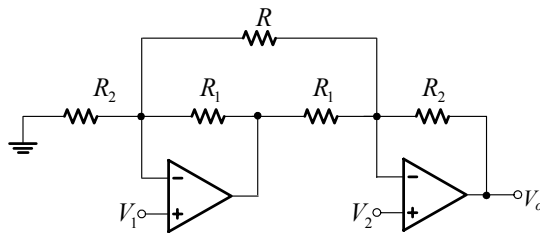


【解析】

使用重疊定理，可得：

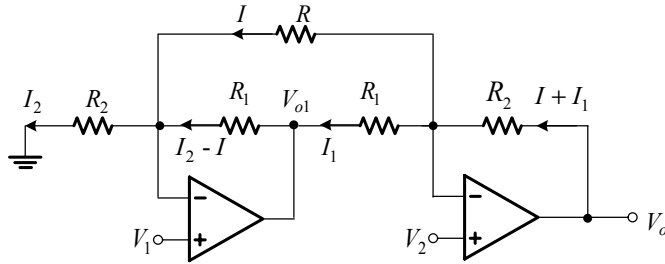
$$V_o = -\frac{R_3}{R_2} \times \left(1 + \frac{2R_1}{R_G}\right)(V_1 - V_2) + V_A$$

• 範題 12 •



Find V_o ?

【解析】



$$\therefore I_2 = \frac{V_1}{R_2}, \quad I = \frac{V_2 - V_1}{R}$$

$$\begin{aligned} \therefore V_{o1} &= V_1 + R_1(I_2 - I) \\ &= V_1 + \frac{R_1}{R_2}V_1 - \frac{R_1}{R}(V_2 - V_1) \end{aligned}$$

$$\begin{aligned} \Rightarrow I_1 &= \frac{V_2 - V_{o1}}{R_1} \\ &= \frac{V_2}{R_1} - \frac{V_1}{R_1} - \frac{V_1}{R_2} + \frac{V_2 - V_1}{R} \end{aligned}$$

$$\begin{aligned} \therefore V_o &= V_2 + R_2(I + I_1) \\ &= V_2 + \frac{R_2}{R}(V_2 - V_1) + \frac{R_2}{R_1}(V_2 - V_1) - V_1 + \frac{R_2}{R}(V_2 - V_1) \\ &= \left(1 + \frac{R_2}{R_1} + \frac{2R_2}{R}\right)(V_2 - V_1) \end{aligned}$$

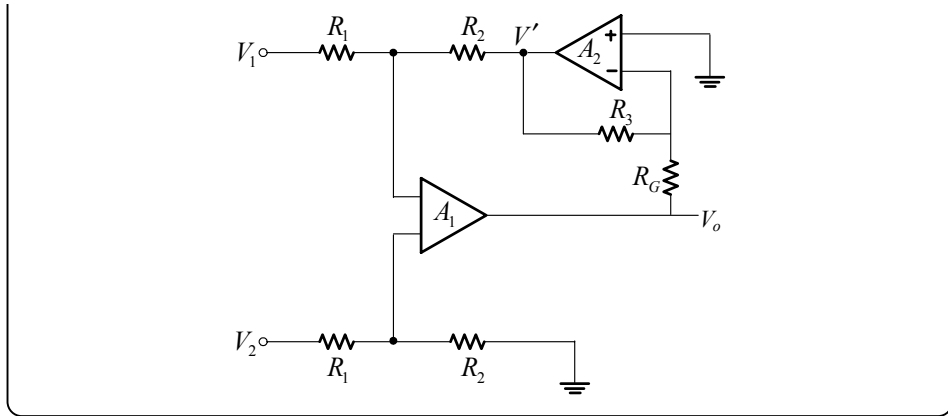
• 範題 13 •

This is a differential amplifier, with $v_o = A(V_1 - V_2)$

(1) Indicated the polarity of A_1 for the circuit to work properly. Explain.

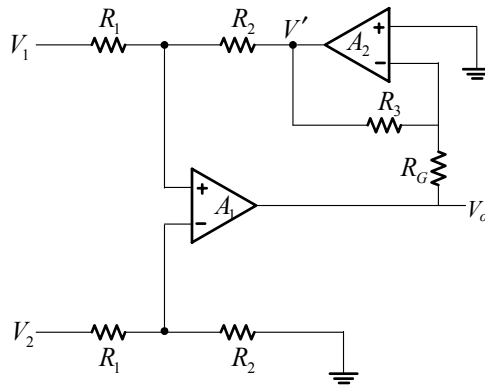
(2) Find A , state any assumptions you have made.

12-30 電子學 (下)



【解析】

(1) 由於必需形成負回授，所以極性如下：



(2) 假設 \$A_1\$ 及 \$A_2\$ 均為理想 OPA，則虛短路成立

$$\Rightarrow V' = -\frac{R_3}{R_G} V_o$$

$$\text{而 } V' = -\frac{R_2}{R_1} V_1 + \frac{R_2}{R_1 + R_2} \left(1 + \frac{R_2}{R_1} \right) V_2 = \frac{R_2}{R_1} (V_2 - V_1)$$

$$\text{得： } -\frac{R_3}{R_G} V_o = \frac{R_2}{R_1} (V_2 - V_1)$$