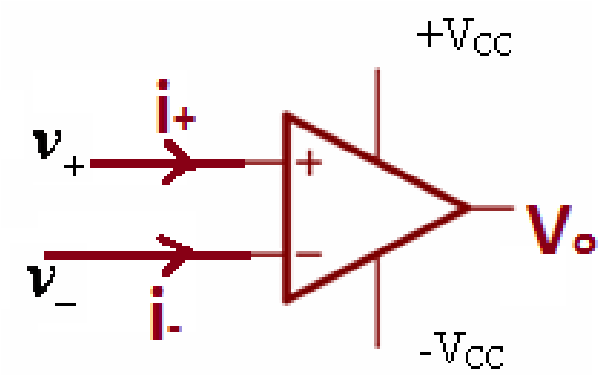
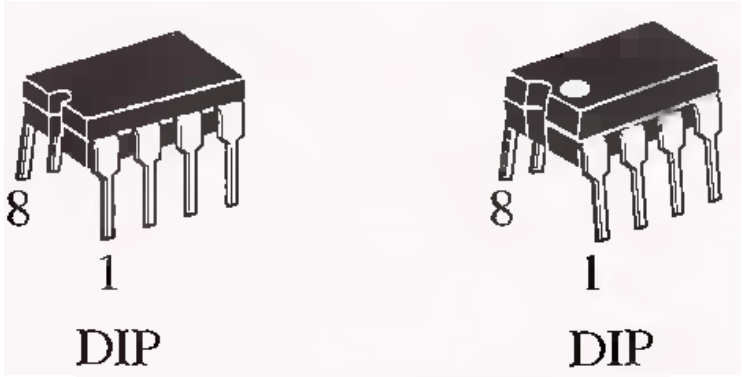
Chương 4:

Opamp (Operational Amplifier – Mạch Khuếch đại thuật toán)

Giới thiệu





dual in-line (DIP)

‘+’ : ngõ vào không đảo

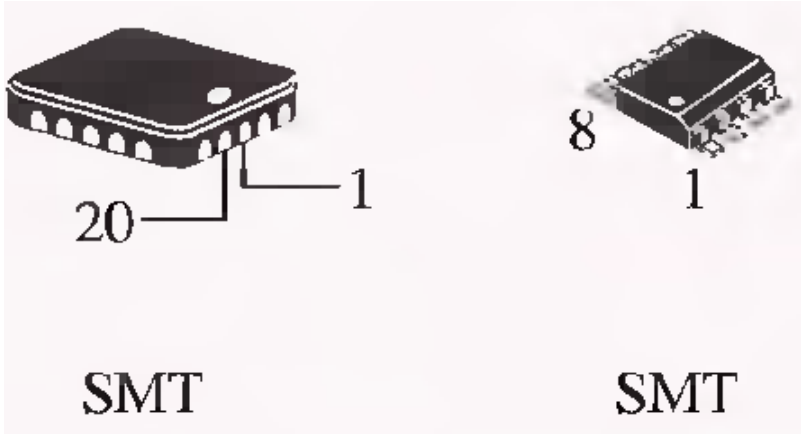
‘-’ : ngõ vào đảo

±Vcc: nguồn cung cấp

Nguồn đôi: ±Vcc

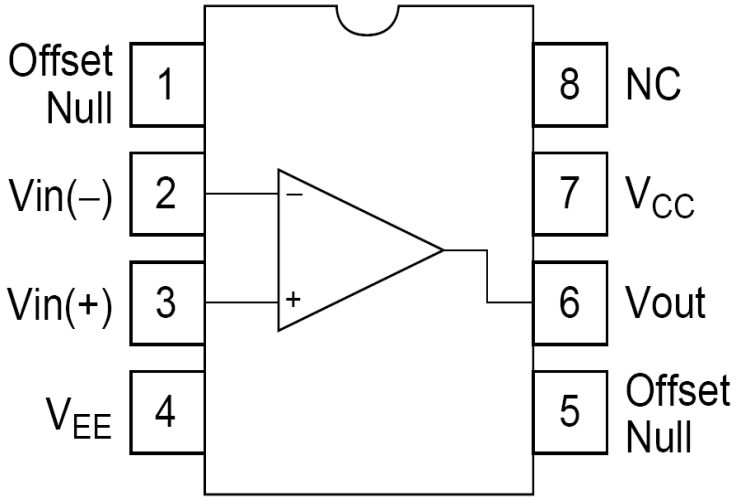
Nguồn đơn: +Vcc, 0V

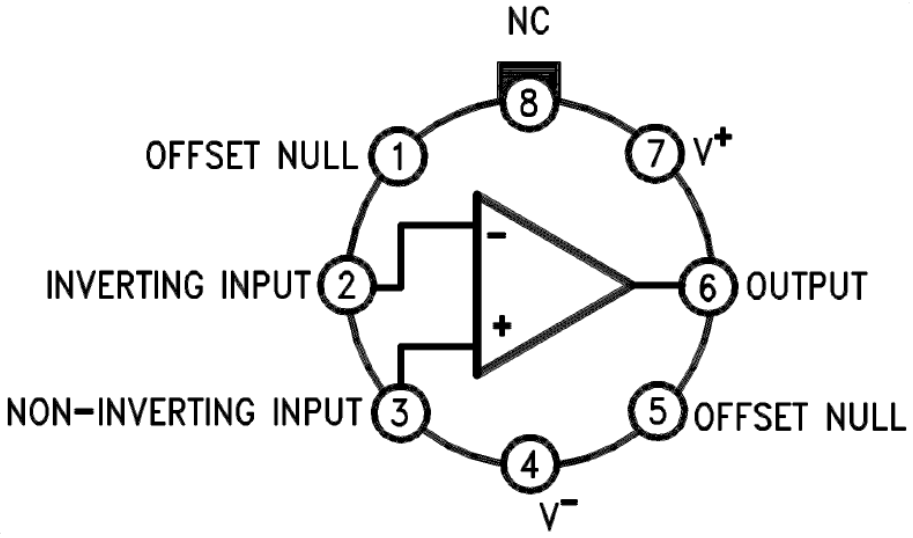
Vo: điện áp ra

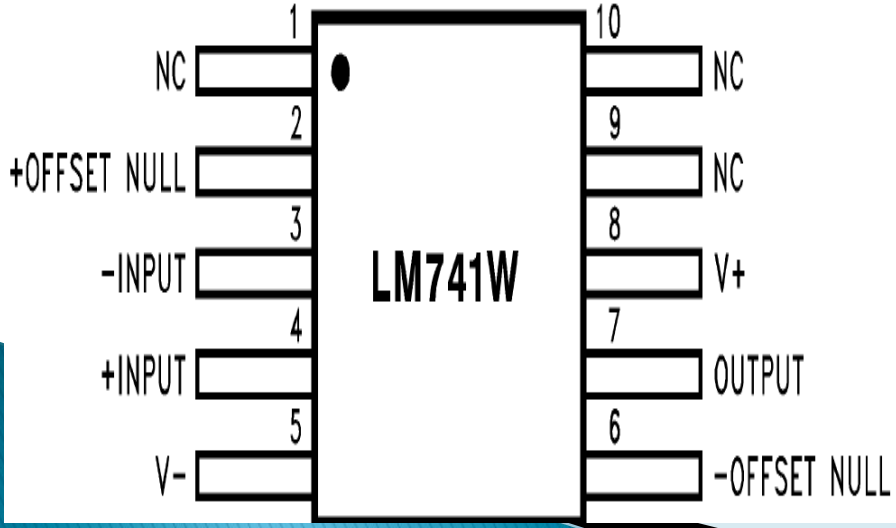


surface-mount technology (SMT)

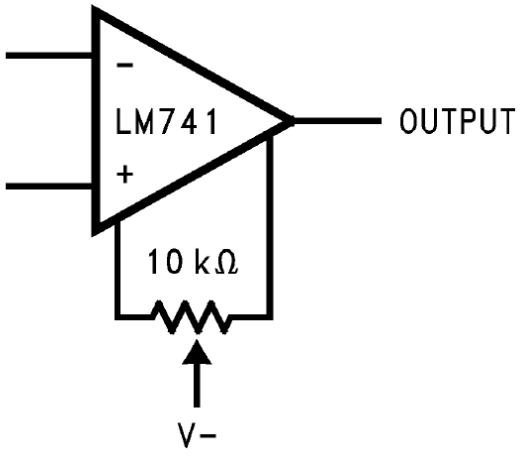
Giới thiệu



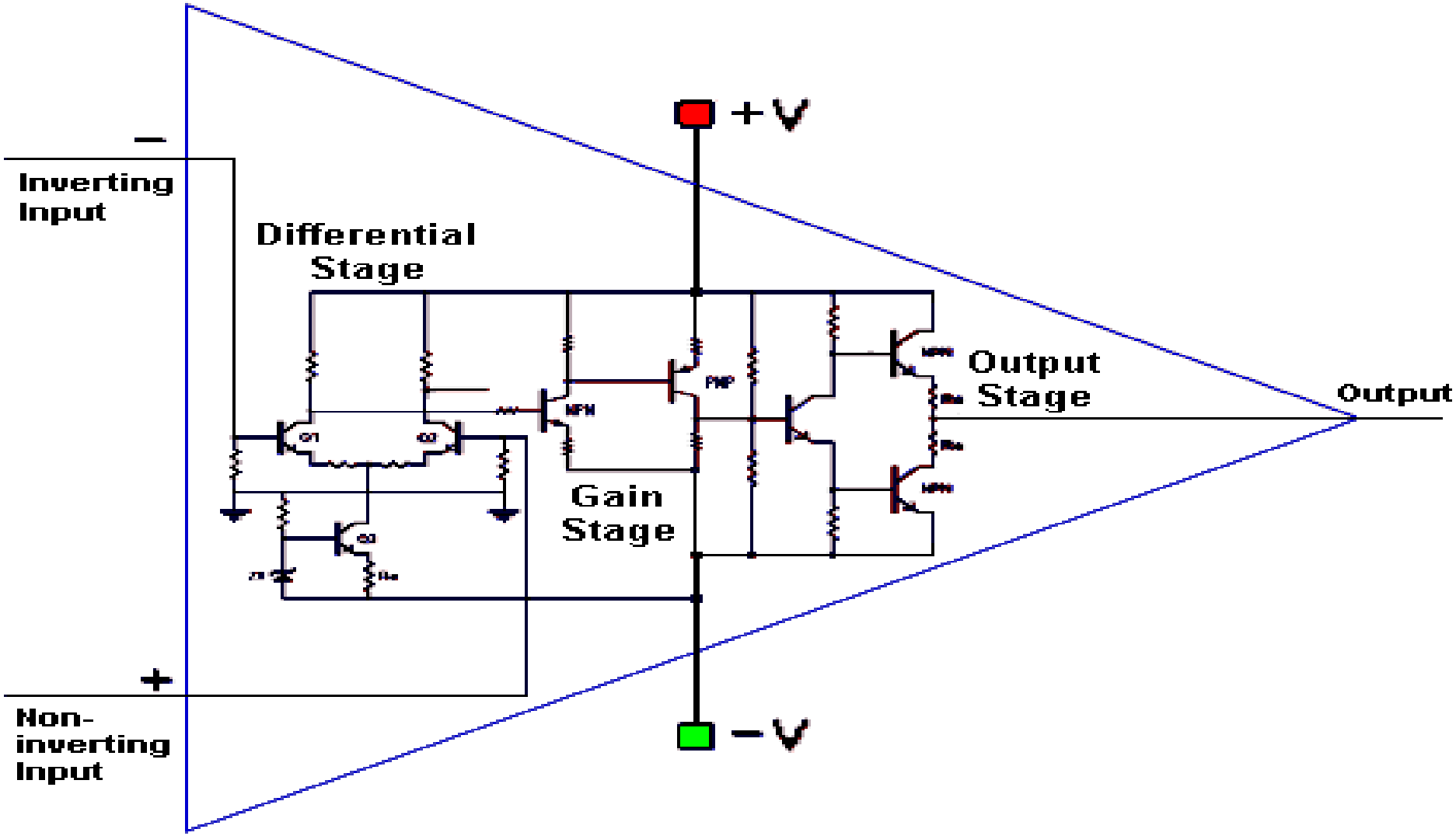




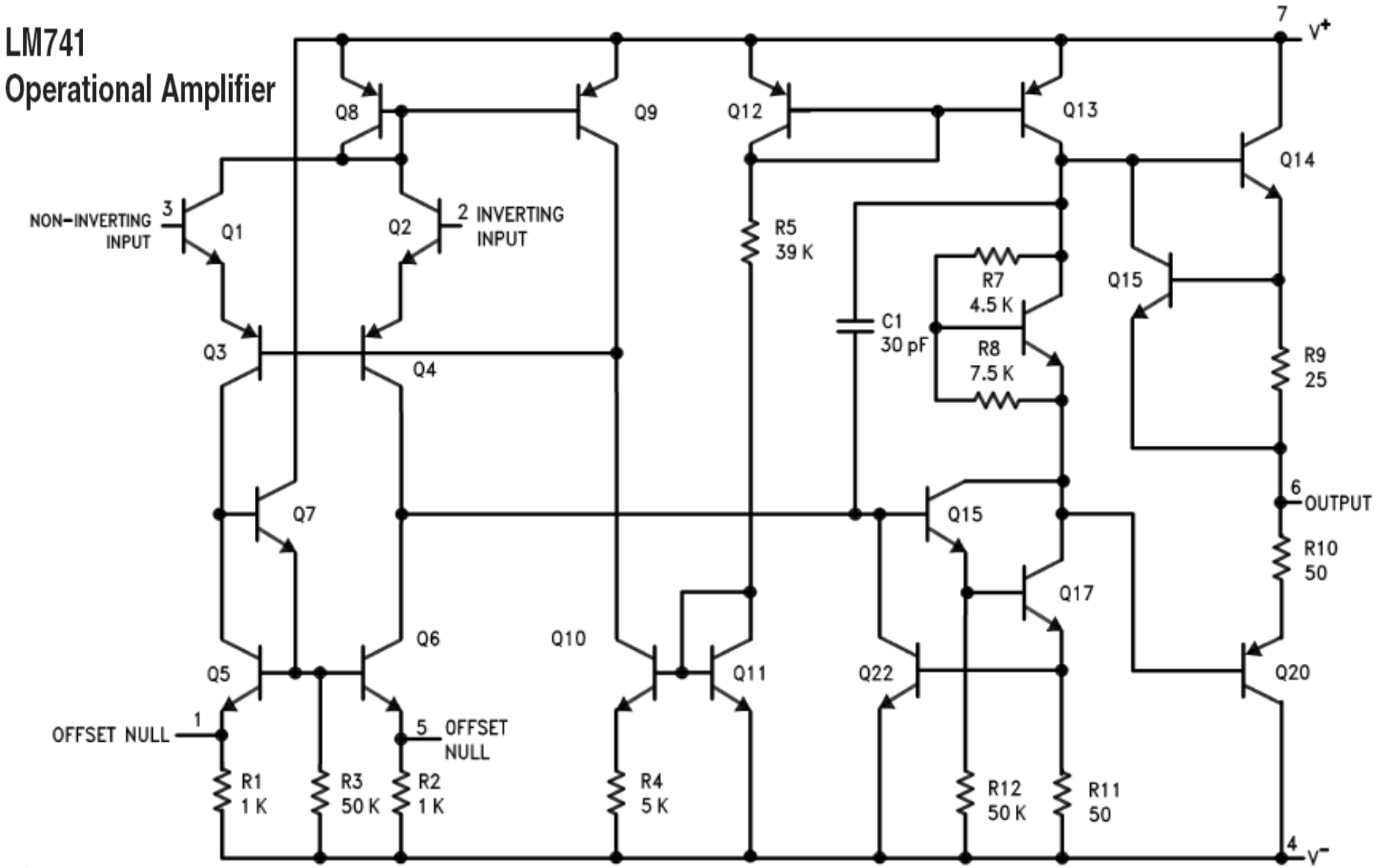
Offset Nulling Circuit



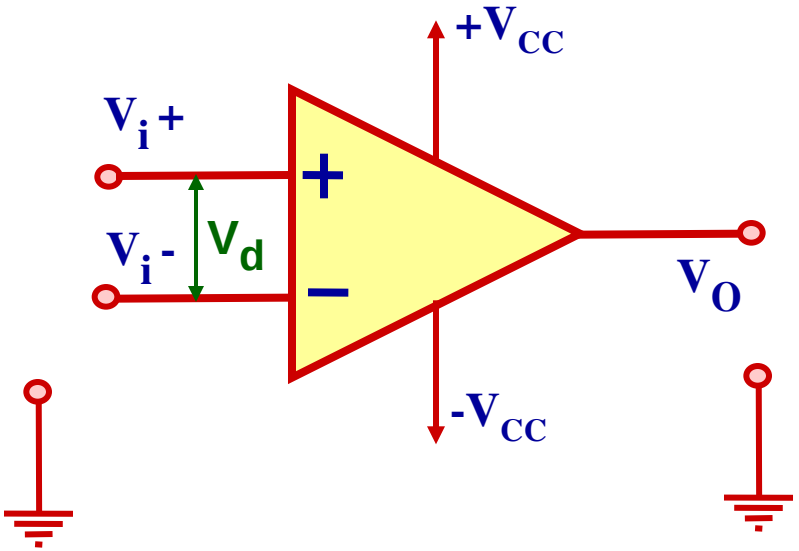
Giới thiệu

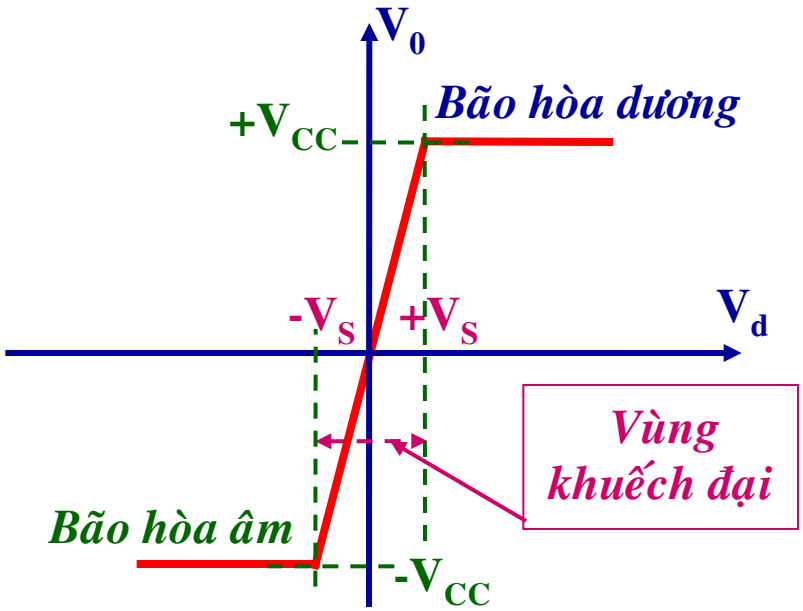

+V
−
Inverting Input
Differential Stage
Output Stage
Output
Gain Stage
+
Non-inverting Input
−V

Giới thiệu

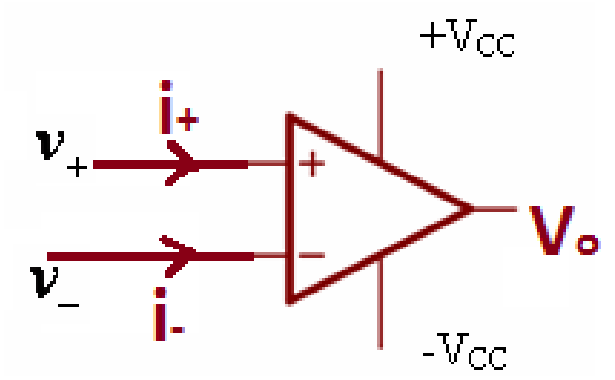

LM741
Operational Amplifier
7
V+
Q8
Q9
Q12
Q13
Q14
NON-INVERTING INPUT
3
Q1
Q2
2
INVERTING INPUT
R5
39 K
R7
4.5 K
C1
30 pF
R8
7.5 K
Q15
R9
25
Q3
Q4
Q7
Q15
6
OUTPUT
R10
50
Q17
Q6
Q10
Q5
Q11
Q22
Q20
OFFSET NULL
1
5
OFFSET NULL
R1
1 K
R3
50 K
R2
1 K
R4
5 K
R12
50 K
R11
50
4
V-

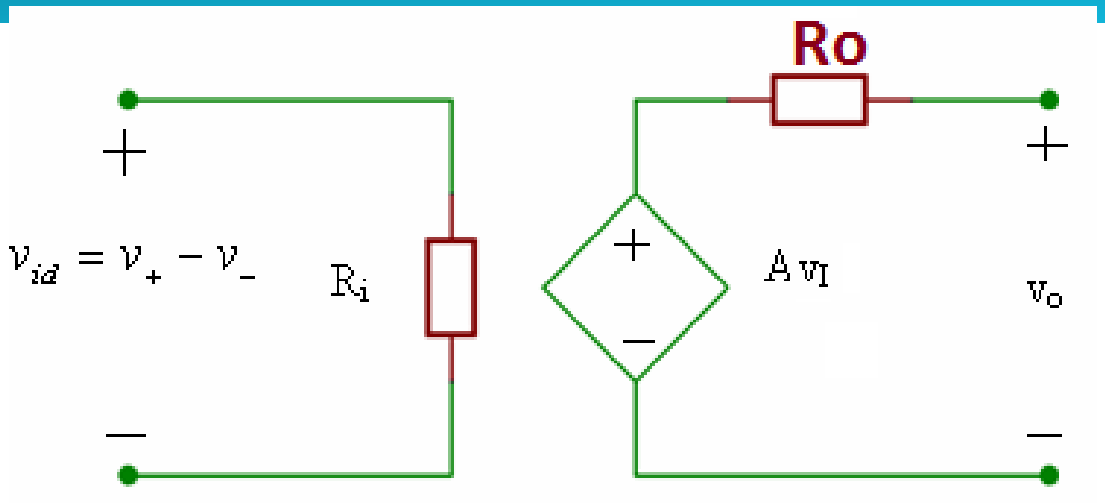
Đặc tuyến


+VCC
Vi+
Vi-
Vd
+
−
VO
-VCC


V0
+VCC
Bão hòa dương
-VS
+VS
Vd
Vùng
khuếch đại
Bão hòa âm
-VCC

Giới thiệu



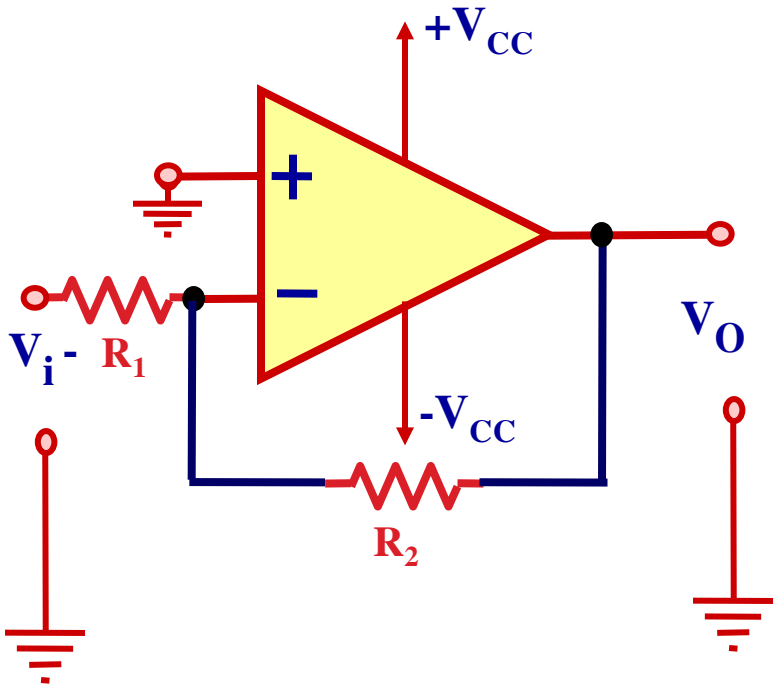


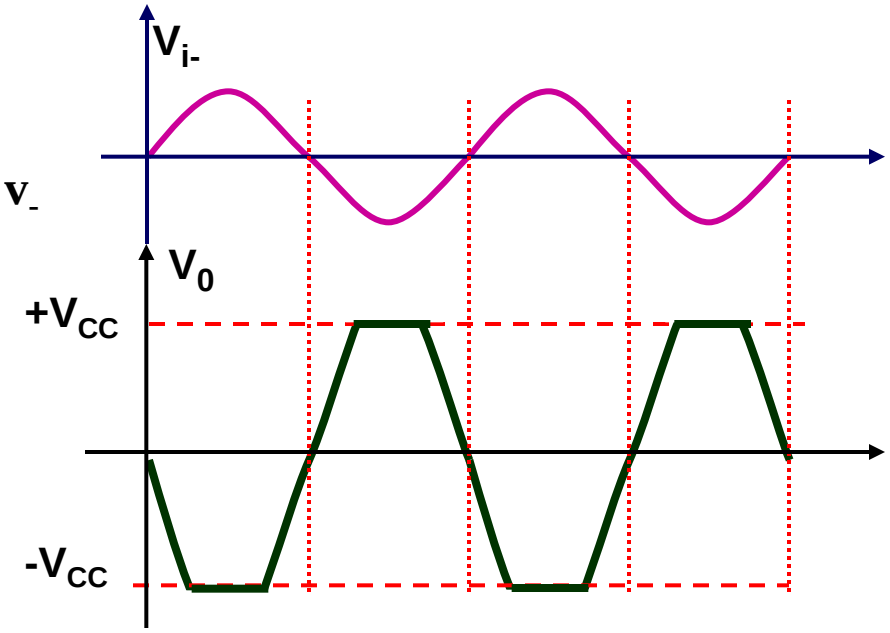
	Lý tưởng	**Thực tế**
Tổng trở vào Ri	∞ →**$i_+ = i_- = 0$ và $v_+ = v_-$**	10^6 - 10^9
Tổng trở ra Ro	0 →Vo= Avid (ko rơi áp trên Ro)	Vài **Ω**
Độ lợi vòng hở A	∞	10^5 : 3.10^6 lần

Mạch khuếch đại dùng Opamp

KĐ đảo

Dùng Opamp lý tưởng $\mathbf{i_+ = i_- = 0}$ và $\mathbf{v_+ = v_-}$

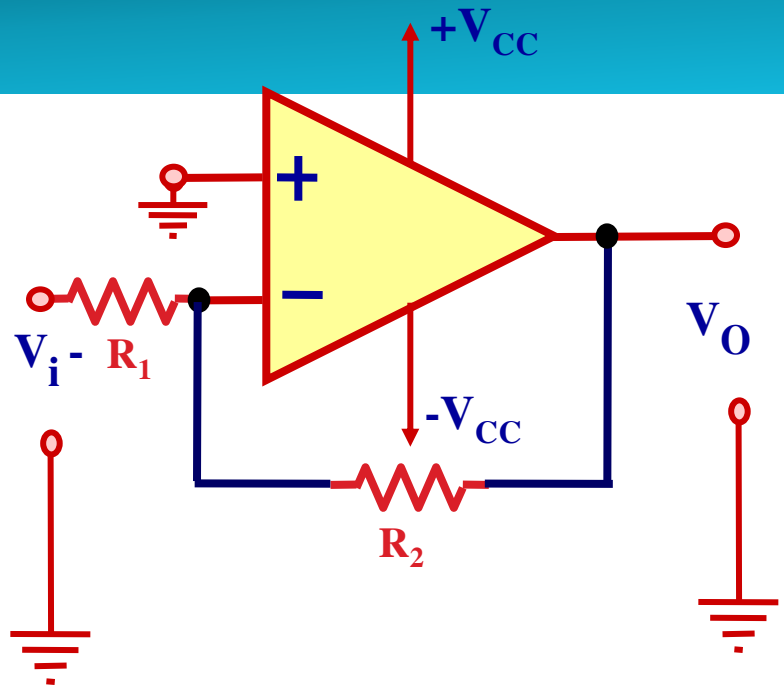




$$V_- = \frac{R_1}{R_1 + R_2}(V_o - V_i) + V_i \quad = V_+ = 0 \quad (phan \quad ap)$$

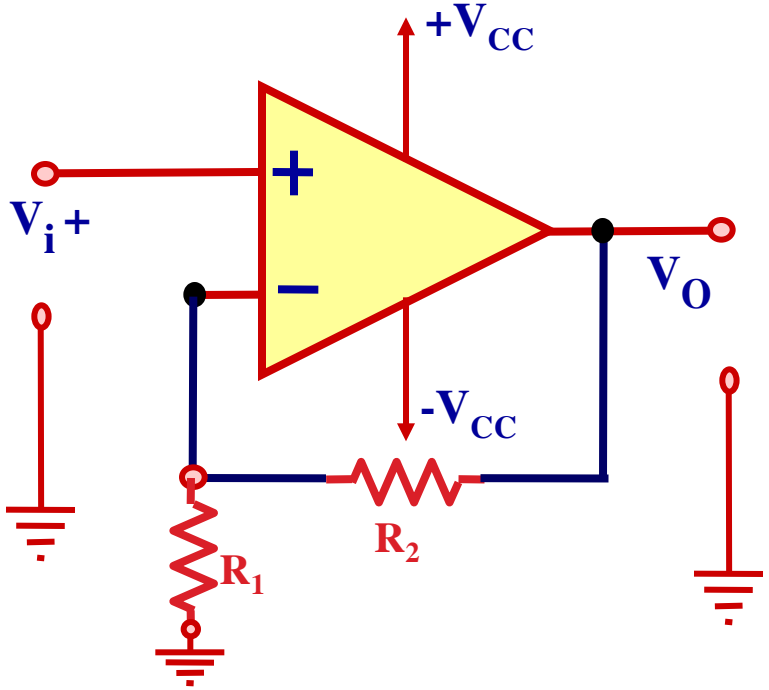
$$\rightarrow \quad V_O = \left(-\frac{R_2}{R_1}\right) \times V_i$$

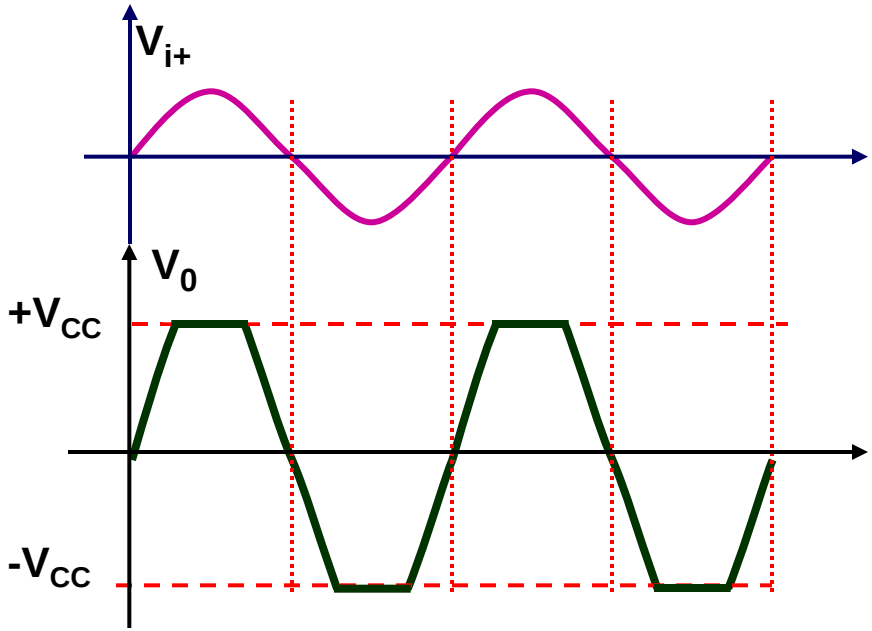
Ứng dụng KĐ - KĐđảo



Mạch khuếch đại dùng Opamp

KĐ không đảo không có phân áp ngõ vào



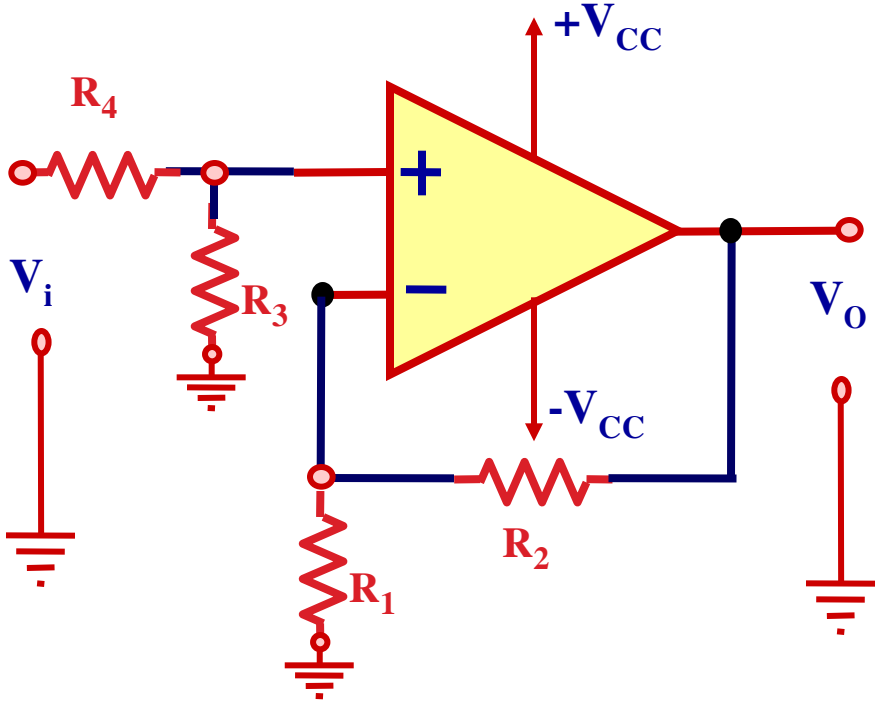


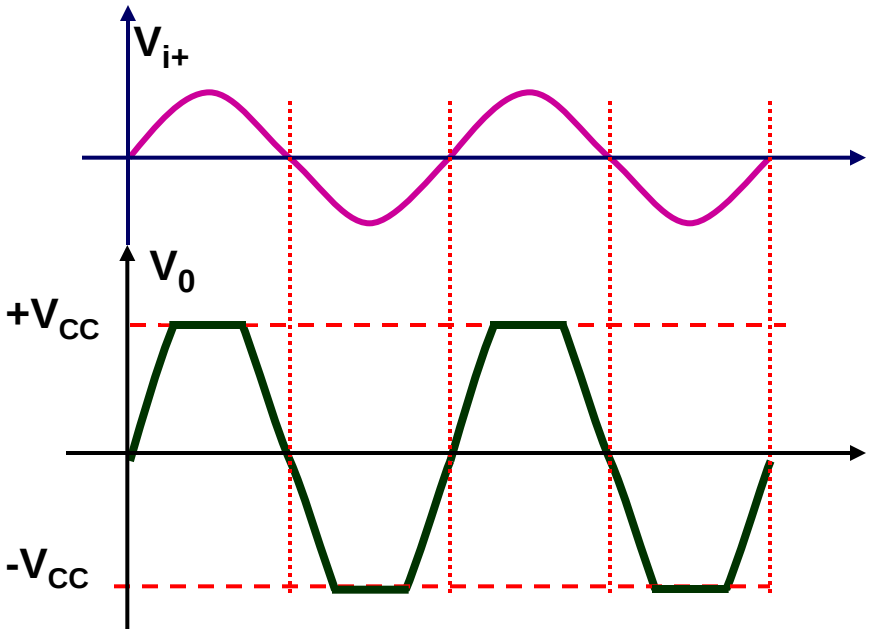
$$V_- = \frac{R_1}{R_1 + R_2} V_o \quad = V_+ = Vi \quad (phan \quad ap)$$

$$\rightarrow \quad V_O = \left(1 + \frac{R_2}{R_1}\right) \times V_i$$

Mạch khuếch đại dùng OPamp

KĐ không đảo có phân áp ngõ vào





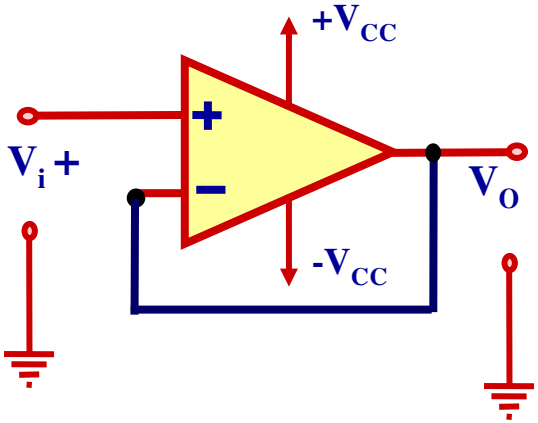
$$V_- = \frac{R_1}{R_1 + R_2} V_o \qquad = V_+ = \frac{R_3}{R_3 + R_4} V_i \quad (phan \quad ap)$$

$\rightarrow$ độ lợi áp

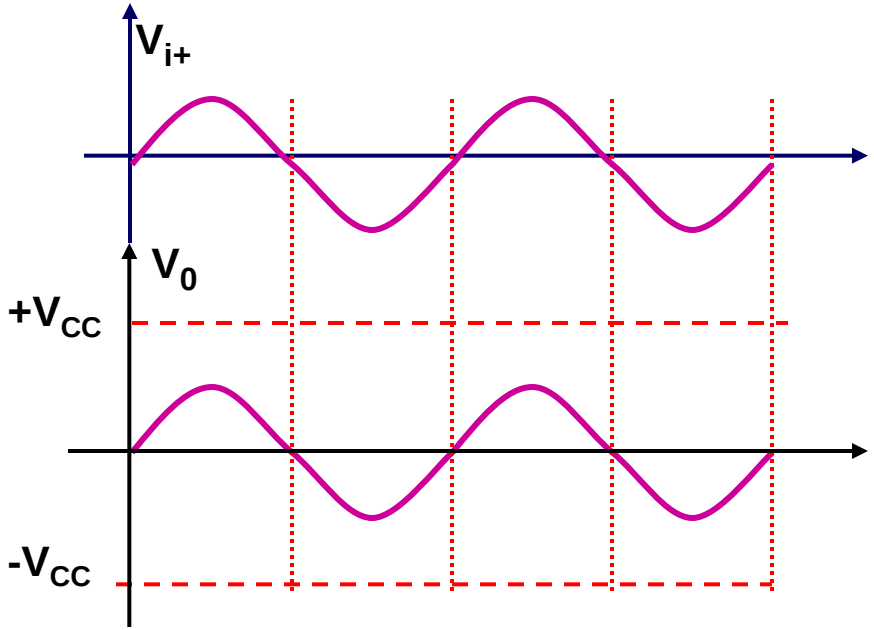
$$Vo = \left\{ \frac{R_3}{R_3 + R_4} \times \frac{R_1 + R_2}{R_1} \right\} xVi$$

Mạch khuếch đại dùng Opamp

KĐ đệm

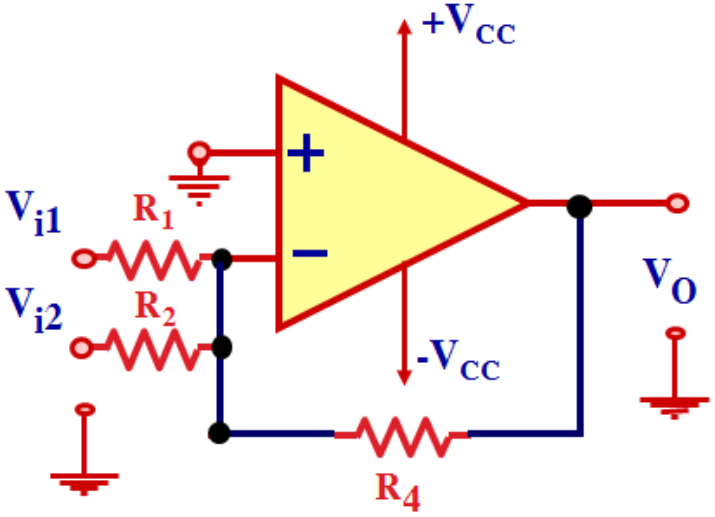


$$V_O = V_i$$

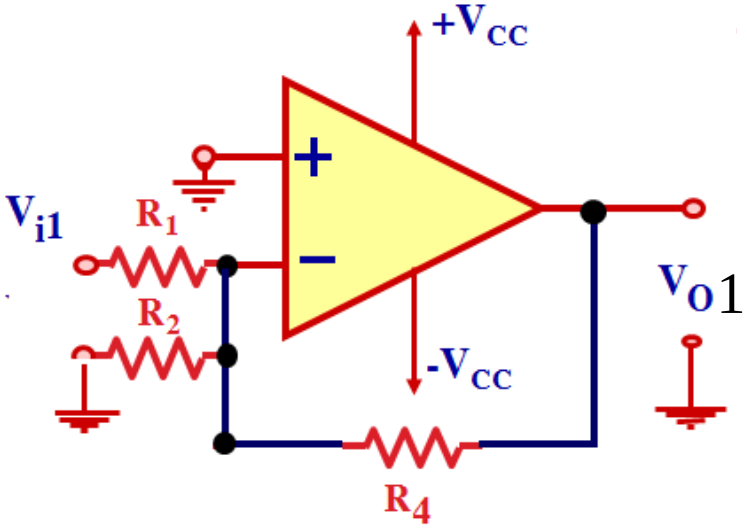


Mạch khuếch đại dùng Opamp

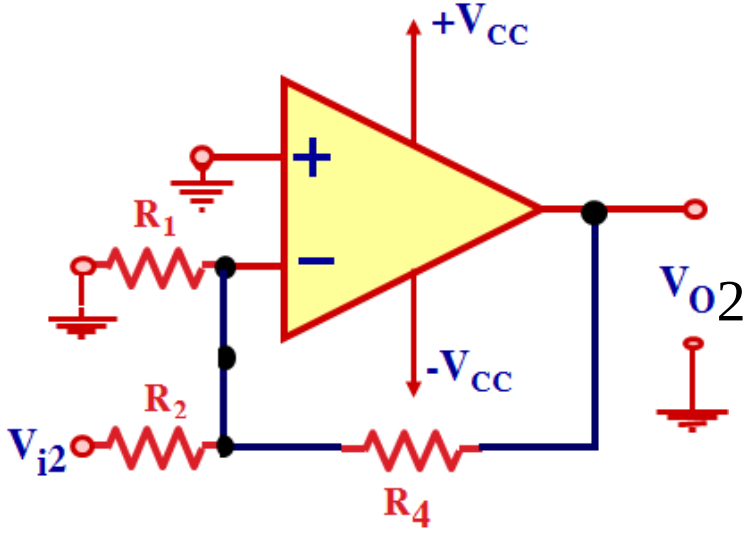
KĐ cộng đảo 2 ngõ vào



Áp dụng định lý xếp chồng



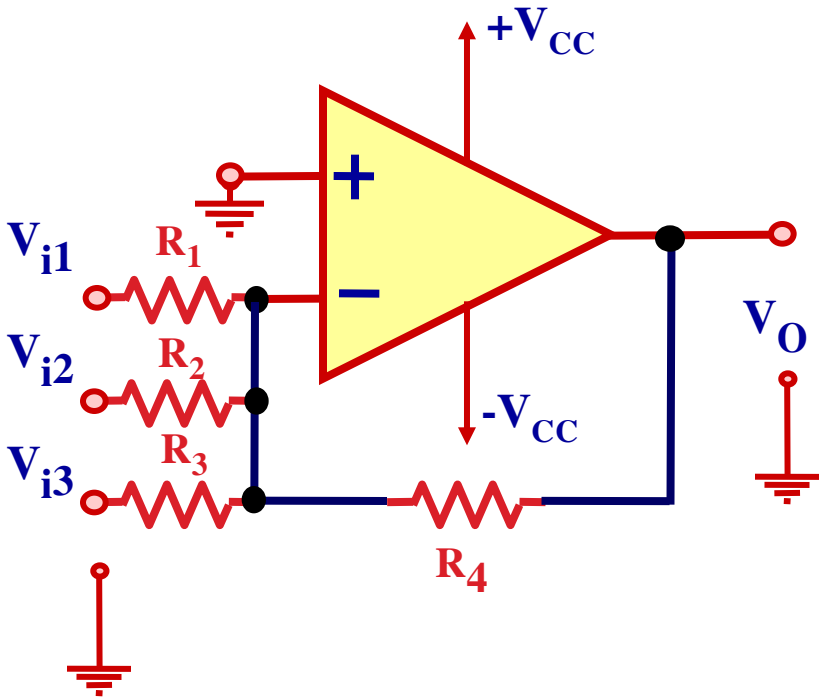
+



$$V_o = V_{o1} + V_{o2} = -\frac{R_4}{R_1}V_{i1} - \frac{R_4}{R_2}V_{i2}$$

Mạch khuếch đại dùng Opamp

KĐ cộng đảo 3 ngõ vào

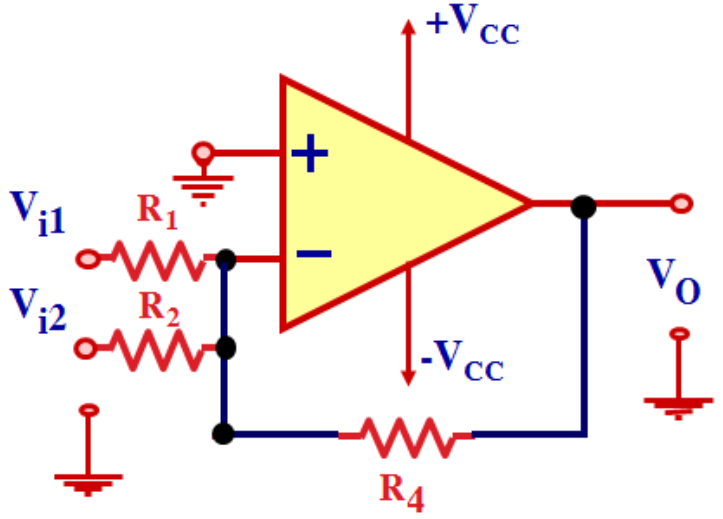


$$V_O = -\left[\frac{R_4}{R_1}V_{i1} + \frac{R_4}{R_2}V_{i2} + \frac{R_4}{R_3}V_{i3}\right]$$

Khi mạch có **n** ngõ vào

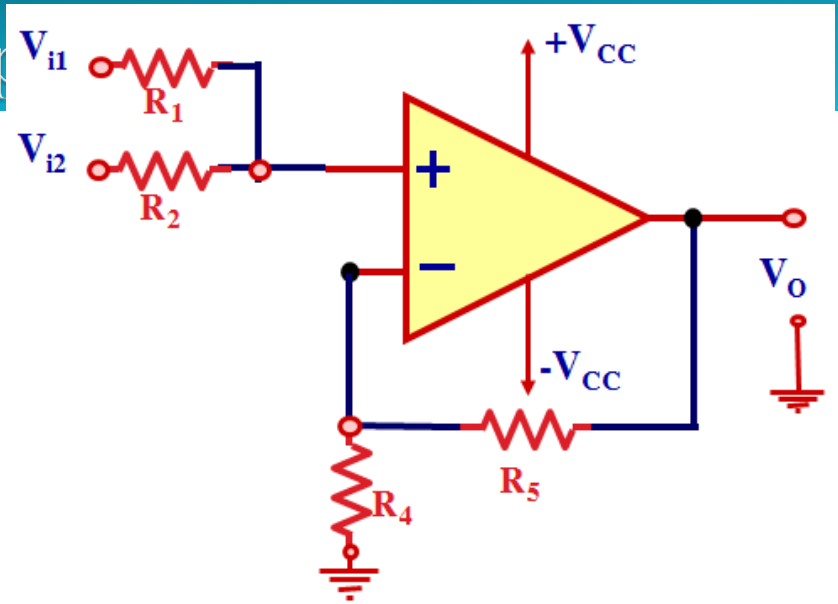
$$V_o = \sum_{i=1}^{n} -\frac{R_F}{R_i}V_i$$

Ứng dụng KĐ – KĐ cộng đảo 2 ngõ vào

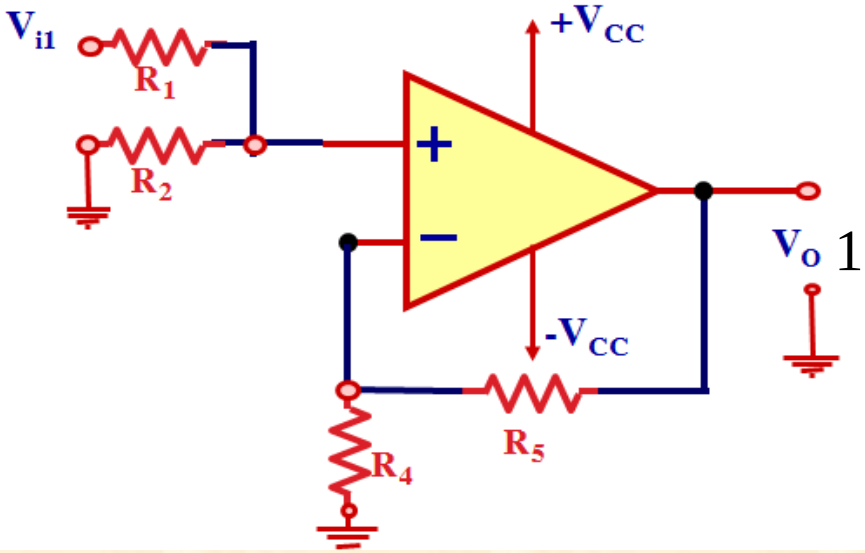


Mạch khuếch đại dùng Opamp

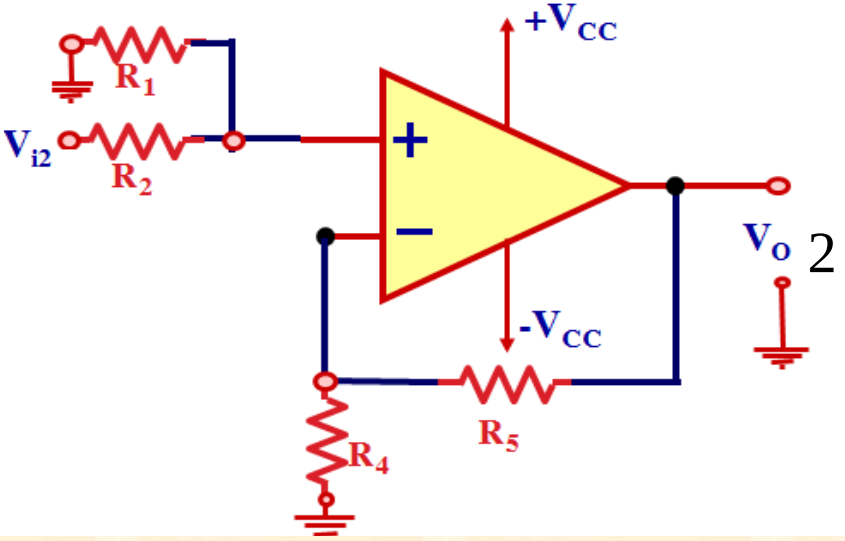
KĐ cộng không đảo 2 ngõ vào



Áp dụng định lý xếp chồng



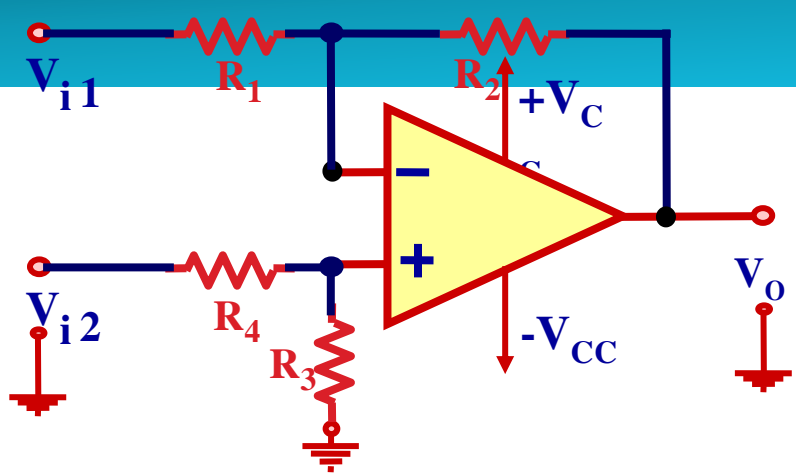
+



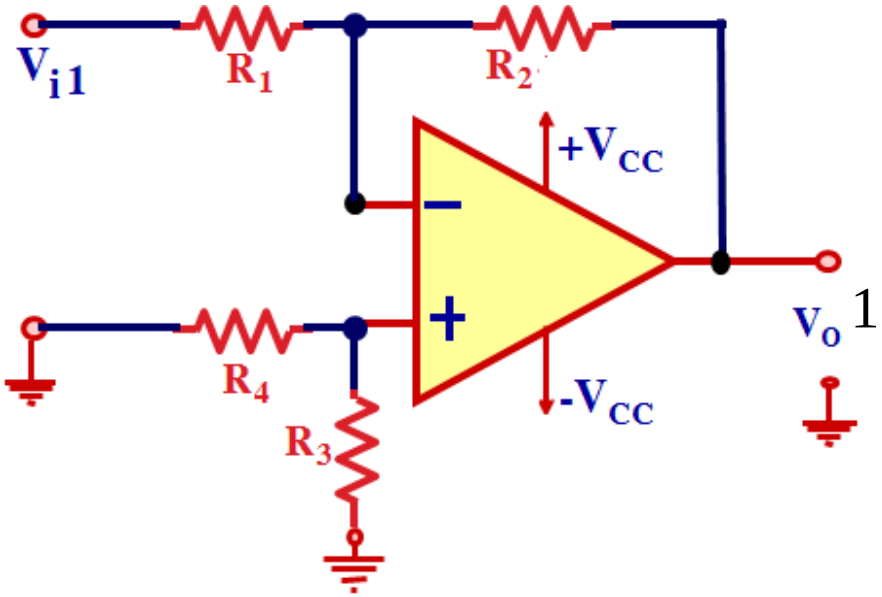
$$Vo = V_{o1} + V_{o2} = (1 + \frac{R_5}{R_4})\left[\frac{R_2}{R_1 + R_2} V_{i1} + \frac{R_1}{R_1 + R_2} V_{i2}\right]$$

Mạch khuếch đại dùng Opamp

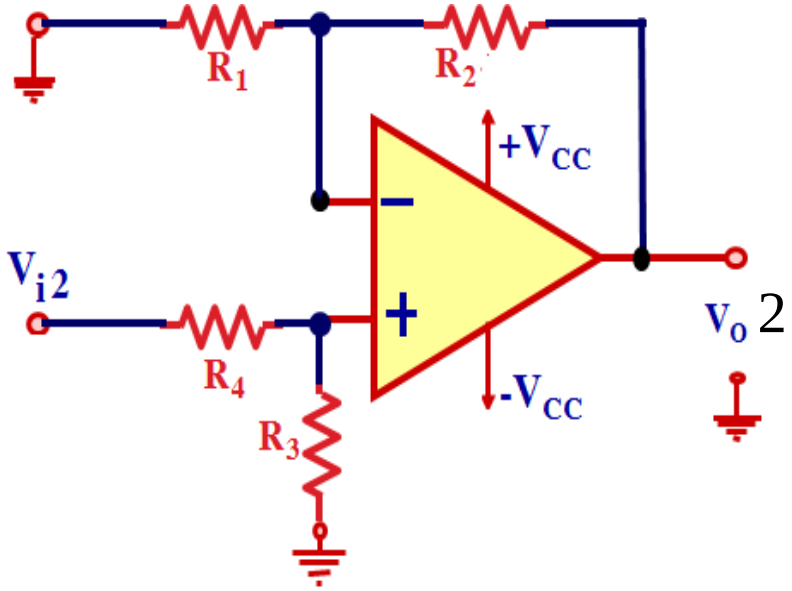
KĐ trừ



Áp dụng định lý xếp chồng

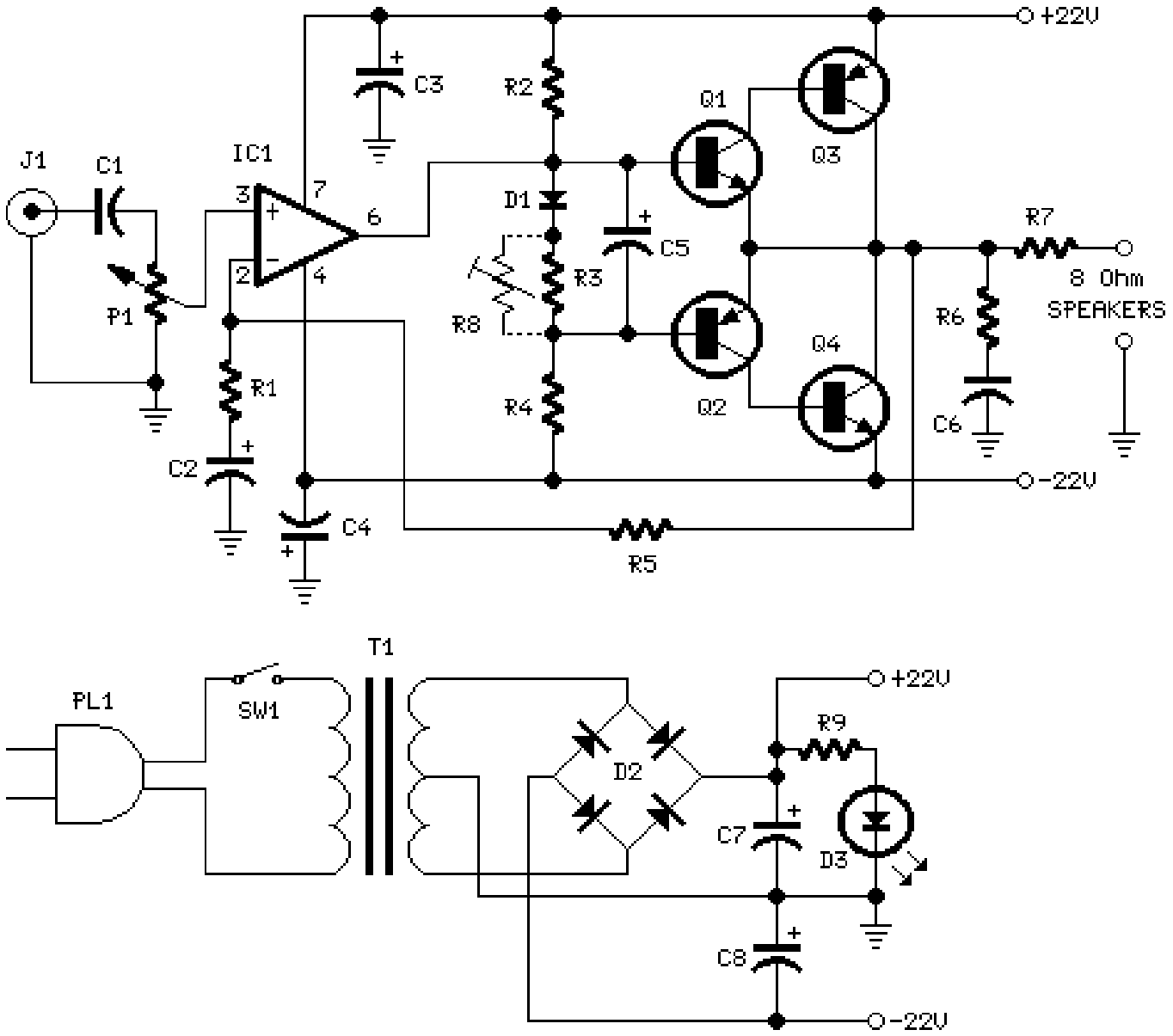


+

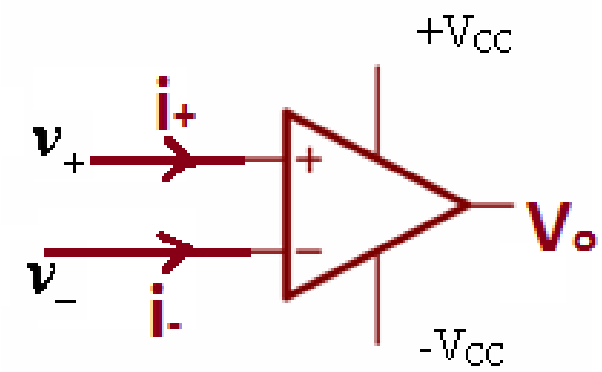


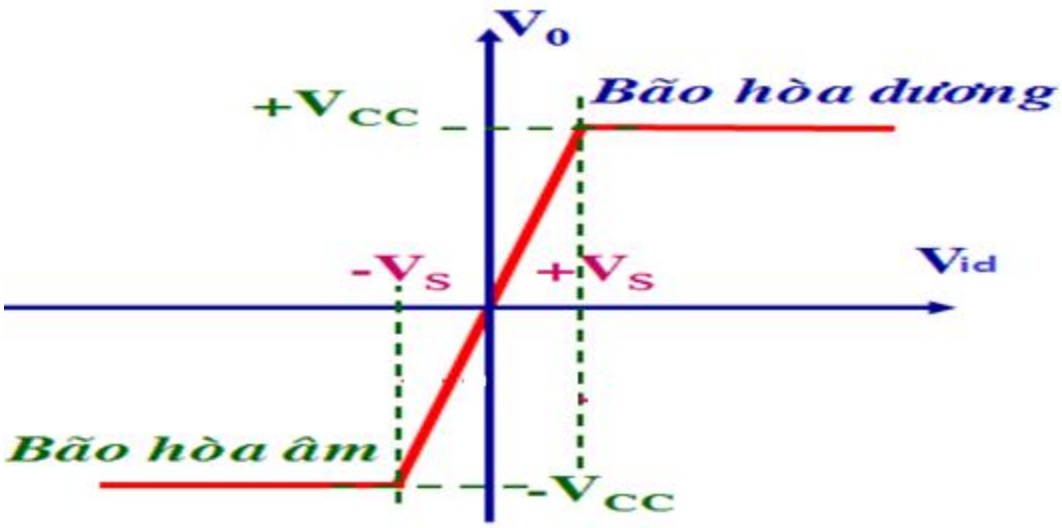
$$Vo = V_{o1} + V_{o2} = -\frac{R_2}{R_1}V_{i1} + (1+\frac{R_2}{R_1})\frac{R_3}{R_3+R_4}V_{i2}$$

Ứng dụng mạch khuếch đại công suất



Mạch so sánh





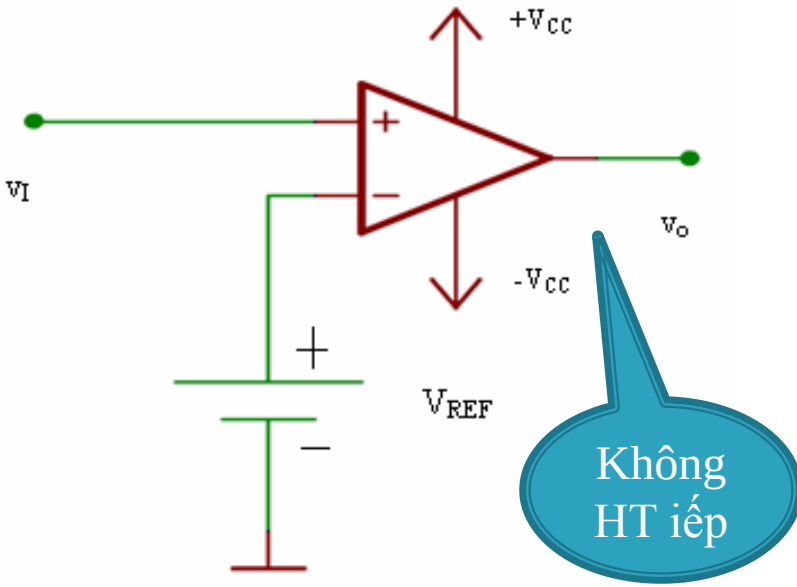
- Ứng dụng vùng phi tuyến bão hòa dương, bão hòa âm của OPAMP để làm mạch so sánh.
- Mạch được xây dựng với cấu **không hồi tiếp** (so sánh) và hoạt động theo **nguyên lý so sánh**:

V+ > V-: Vo= +Vcc (bão hòa dương)

V- > V+: Vo= -Vcc (bão hòa âm)

Mạch so sánh

Mạch so sánh không đảo



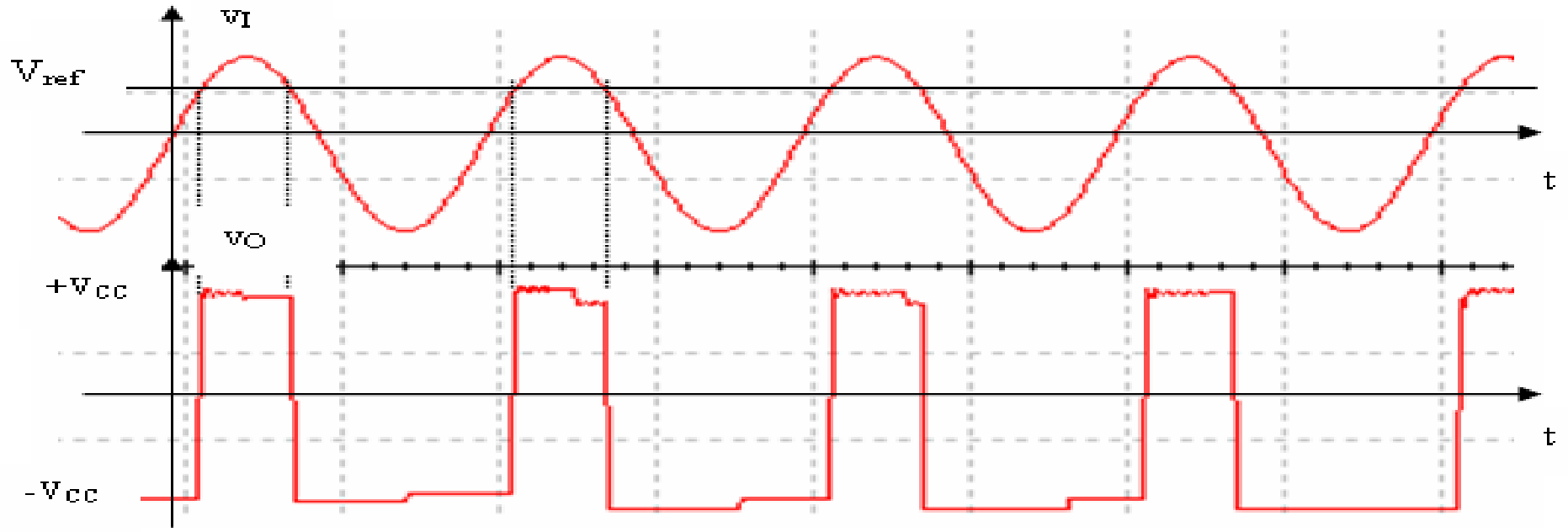
Theo mạch trên: **V+ = Vi**

V- = V_{REF}

Theo nguyên lý so sánh:

V+ = Vi > V- = V_{REF} thì Vo = +Vcc

V+ = Vi < V- = V_{REF} thì Vo = -Vcc



Mạch so sánh

Mạch so sánh đảo

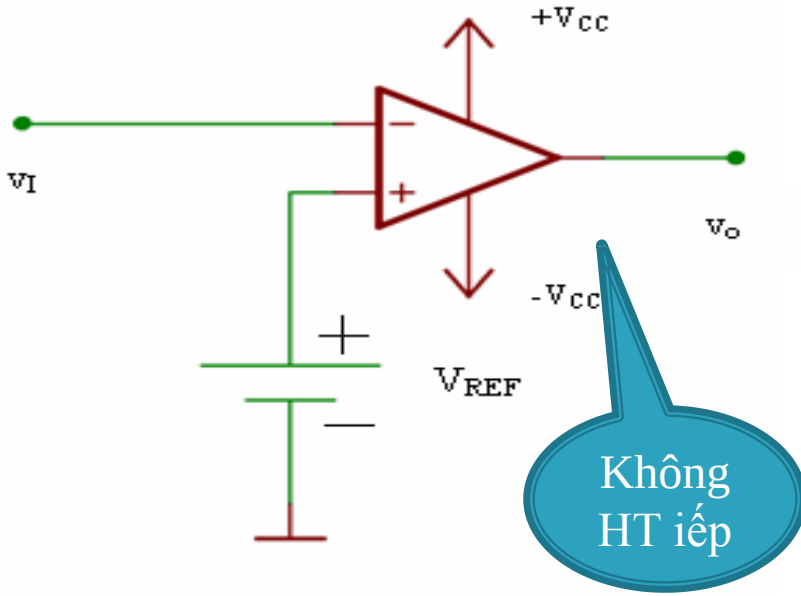
Theo mạch trên: $V+ = V_{REF}$

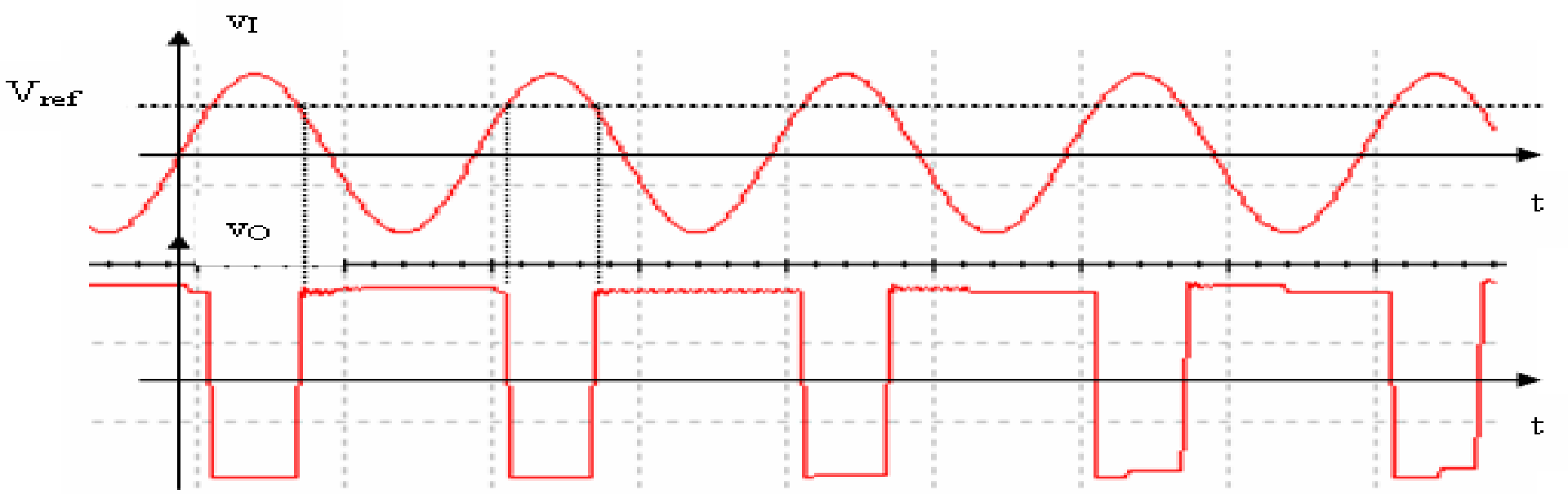
$V- = Vi$

Theo nguyên lý so sánh:

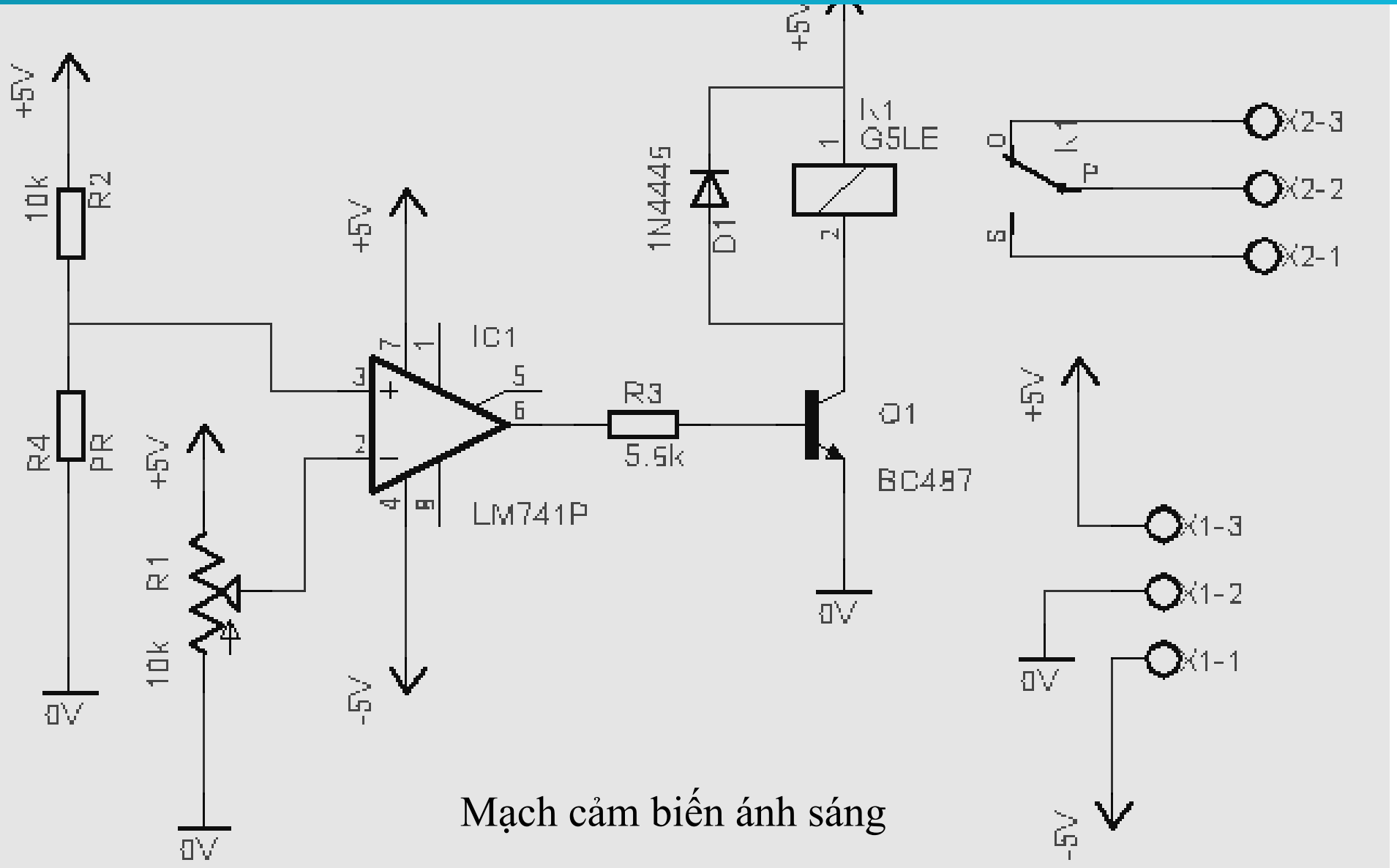
$V+ = V_{REF} > V- = Vi$ thì $Vo = +Vcc$

$V+ = V_{REF} < V- = Vi$ thì $Vo = -Vcc$





Ứng dụng mạch so sánh



Mạch cảm biến ánh sáng