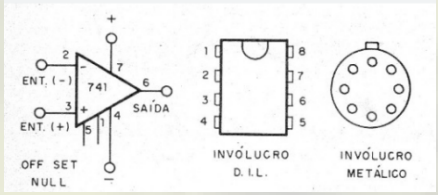
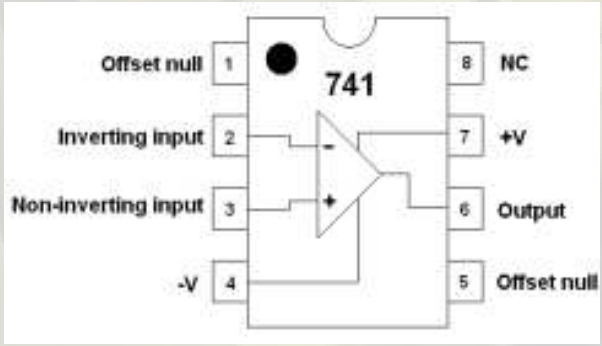
PSI-3212 Laboratório de Circuitos Elétricos

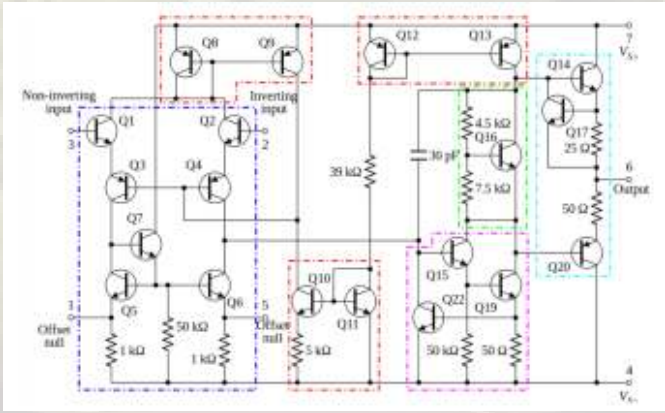
Experiência 06

CIRCUITOS COM AMPLIFICADOR OPERACIONAL

(AmpOp 741)







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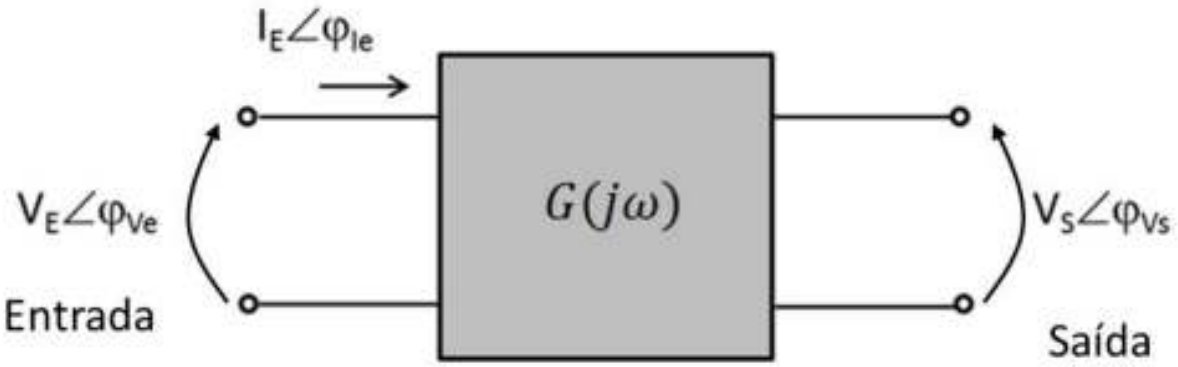
Objetivos

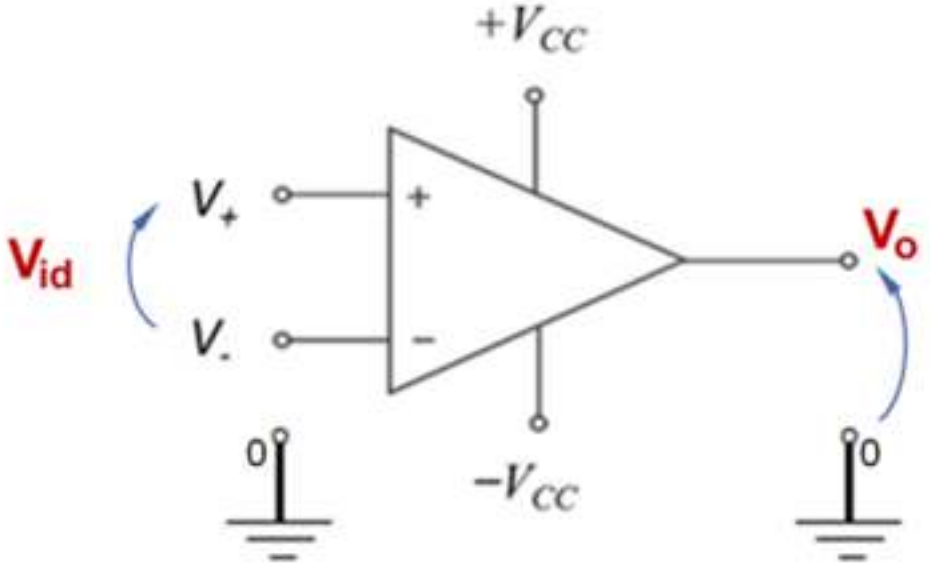
Análise de Circuitos com AmpOp

- Estudar o Amplificador Operacional (AmpOp)
- Entender o func. do AmpOp ideal/real
- Aplicar leis de Kirchhoff p resolver circuitos com AmpOp

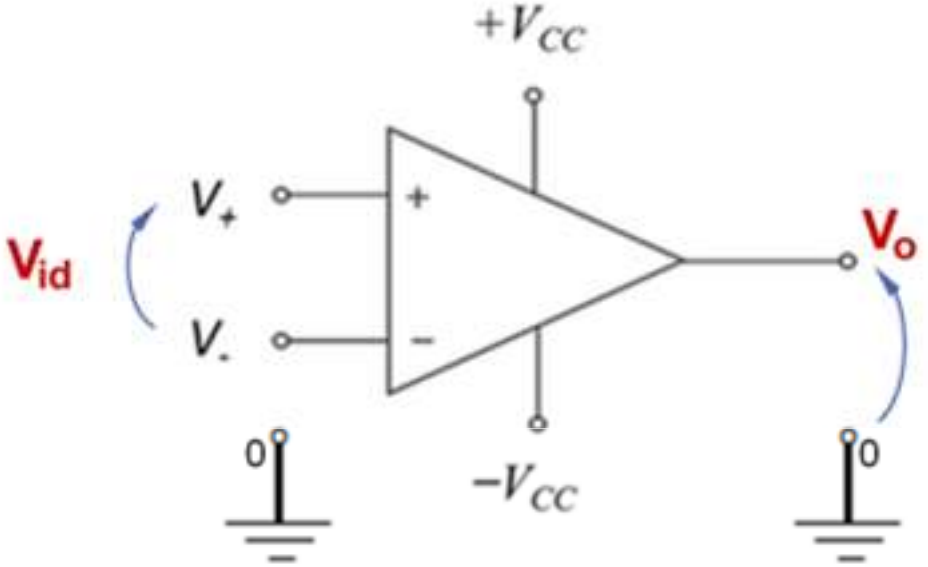
Introdução



AMPLIFICADOR OPERACIONAL



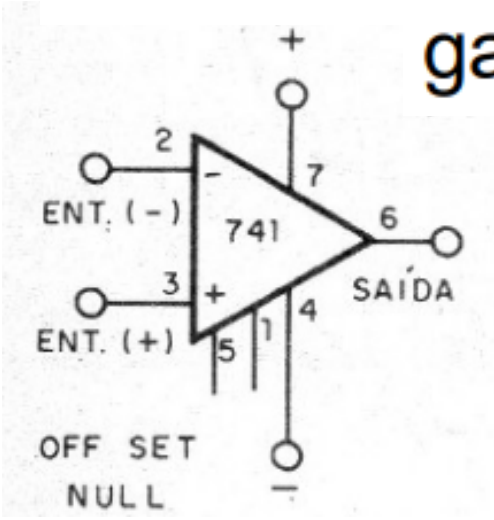
Ganho de tensão “em malha aberta”

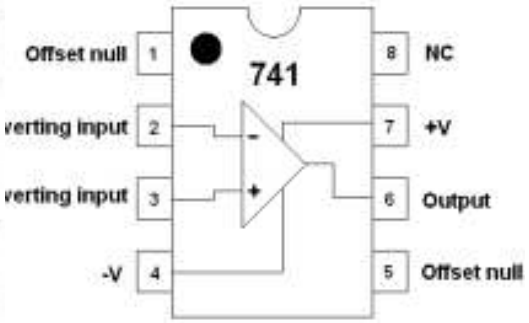


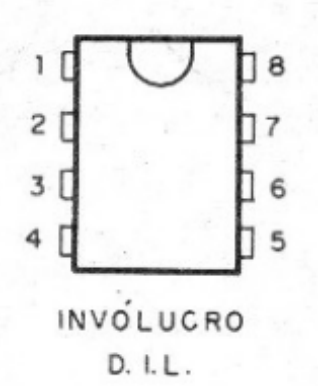
Ganho: $A = \frac{V_o}{V_{id}} = \frac{V_o}{V_+ - V_-}$

- $A = \infty \rightarrow AmpOp\ ideal$
- $A = 10^4 - 10^6 \rightarrow AmpOp\ real$
- $V_+ - V_- \approx 0$

ganho (A) é da ordem de 10^4 a 10^6

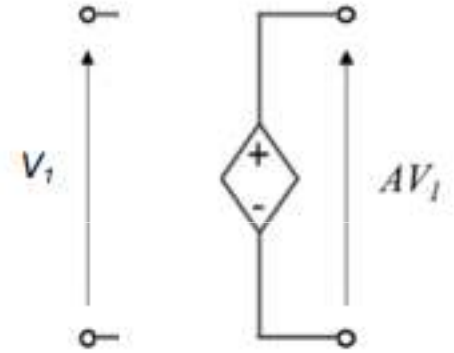


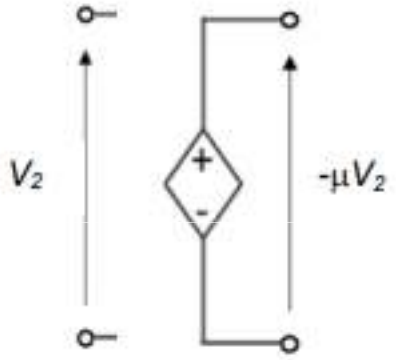




MODELO EQUIVALENTE DO AMPLIFICADOR OPERACIONAL

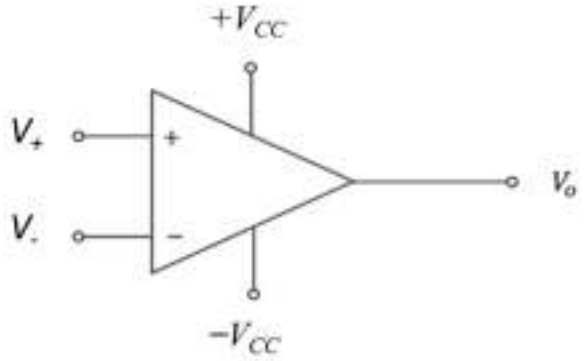
- gerador vinculado controlado por tensão



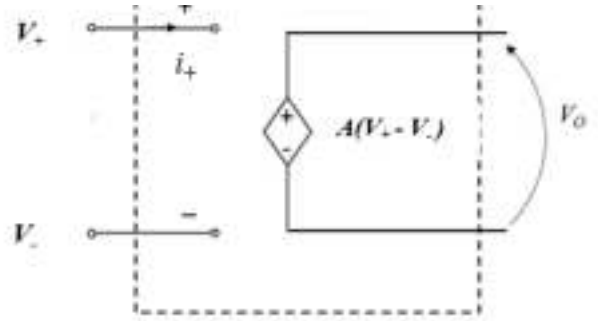


(b)

Gerador Vinculado Controlado por Tensão.



(a) Representação esquemática do AmpOp.



(b) Modelo equivalente do AmpOp utilizando gerador vinculado.

AMPLIFICADOR COM REALIMENTAÇÃO NEGATIVA

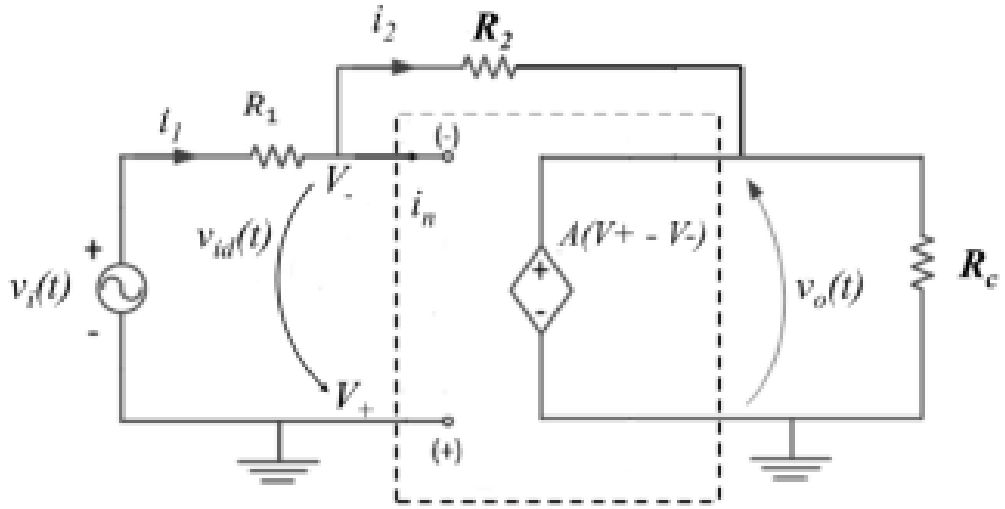


Figura 5 - Circuito inversor com AmpOp representado pelo modelo equivalente.

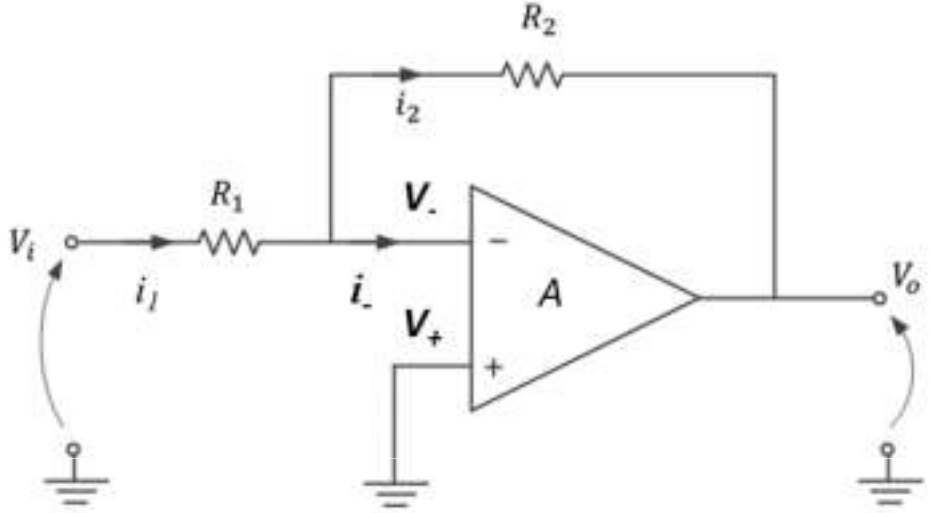
$V_+ = 0$. $v_o(t) = A.v_{id}(t)$. Logo $v_o(t) = A.(V_+ - V_-) = -A.V_-$ ou: $V_- = -v_o(t) / A$

como $i_- = 0 \rightarrow i_1 = i_2$, temos: $\frac{v_i - V_-}{R_1} = \frac{V_- - v_o}{R_2} \rightarrow \frac{v_i + v_o/A}{R_1} = \frac{-v_-/A - v_o}{R_2}$

Resulta que:

$$\frac{v_o}{v_i} = -\frac{R_2}{R_1}\left(\frac{1}{1+\frac{1}{A}\left(1+\frac{R_2}{R_1}\right)}\right)$$

Amplificador inversor com AmpOp ideal



Vale a relação :

$$V_o = -\frac{R_2}{R_1} V_1$$

Ganho: $A = \frac{V_o}{V_i} = -\frac{R_2}{R_1}$

Figura 2 – Circuito inversor utilizando Amplificador Operacional.

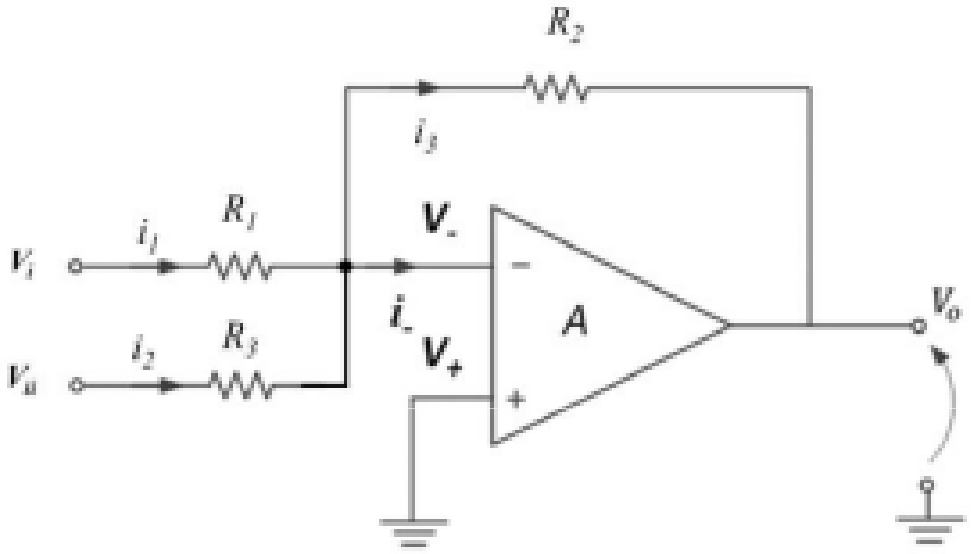
como $V_+ = 0\,V$ (seu terminal está aterrado), então $V_- = 0\,V$.

"curto- circuito virtual"

$$i_2 = i_1 \quad \text{Assim, } i_1 = \frac{V_i - 0}{R_1} \quad \text{e} \quad i_2 = \frac{0 - V_o}{R_2}$$

Dividindo as correntes $A_v = \frac{V_o}{V_i} = -\frac{R_2}{R_1}$ $V_o = -\frac{R_2}{R_1} V_i$

Circuito Amplificador Somador Inversor



$$V_o = -\frac{R_2}{R_1}V_i - \frac{R_2}{R_3}V_u$$

Principais equações do AmpOp:

- soma
- subtração
- multiplicação
- divisão

Outras equações do AmpOp:

- equação diferencial
- equação integral
- equação exponencial
- equação logarítmica
- .....

PARTE EXPERIMENTAL

- Montar o AmpOp – “malha aberta”
  - Montar o circuito amplificador inversor
  - Análise do circuito montado
- Levantamento da Curva de Transferência do circuito amplificador (realimentada)
  - Passo a passo de tensão Vin x Vo
  - Sinal senoidal
- Circuito Somador Inversor AC + DC

AmpOp – “malha aberta”

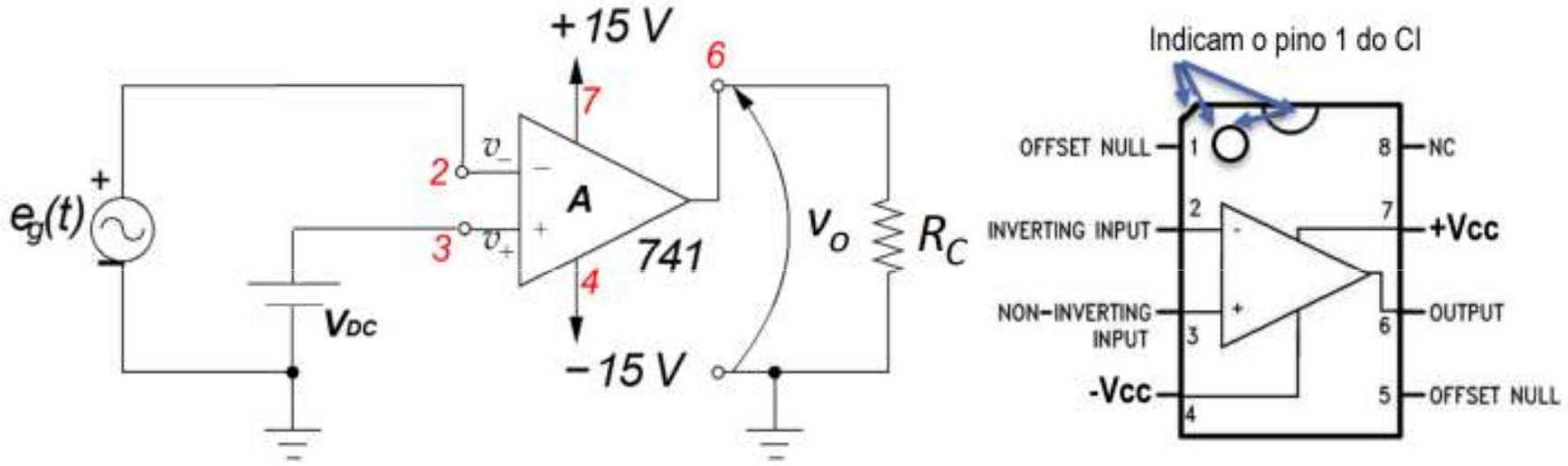
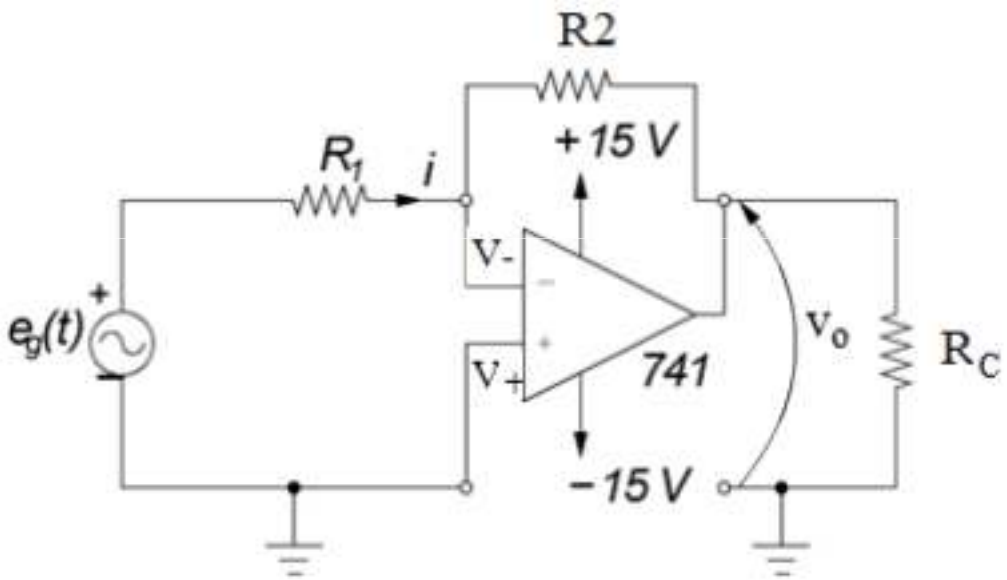
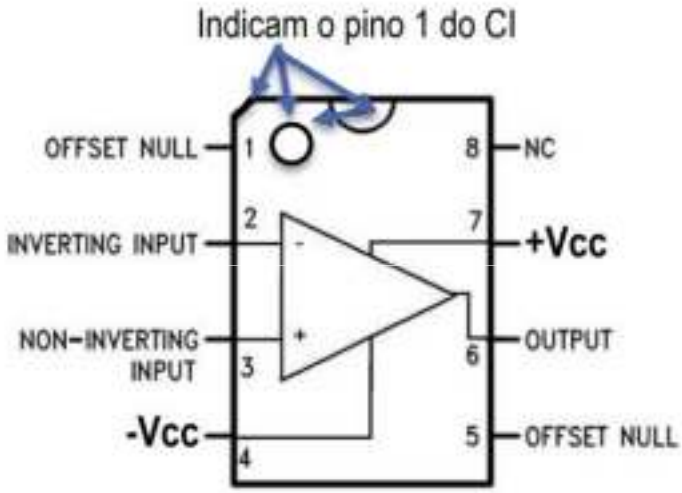


Figura 1: Circuito comparador com operacional e a pinagem do 741.

Curva de Transferência e Amplificador Inversor em AC

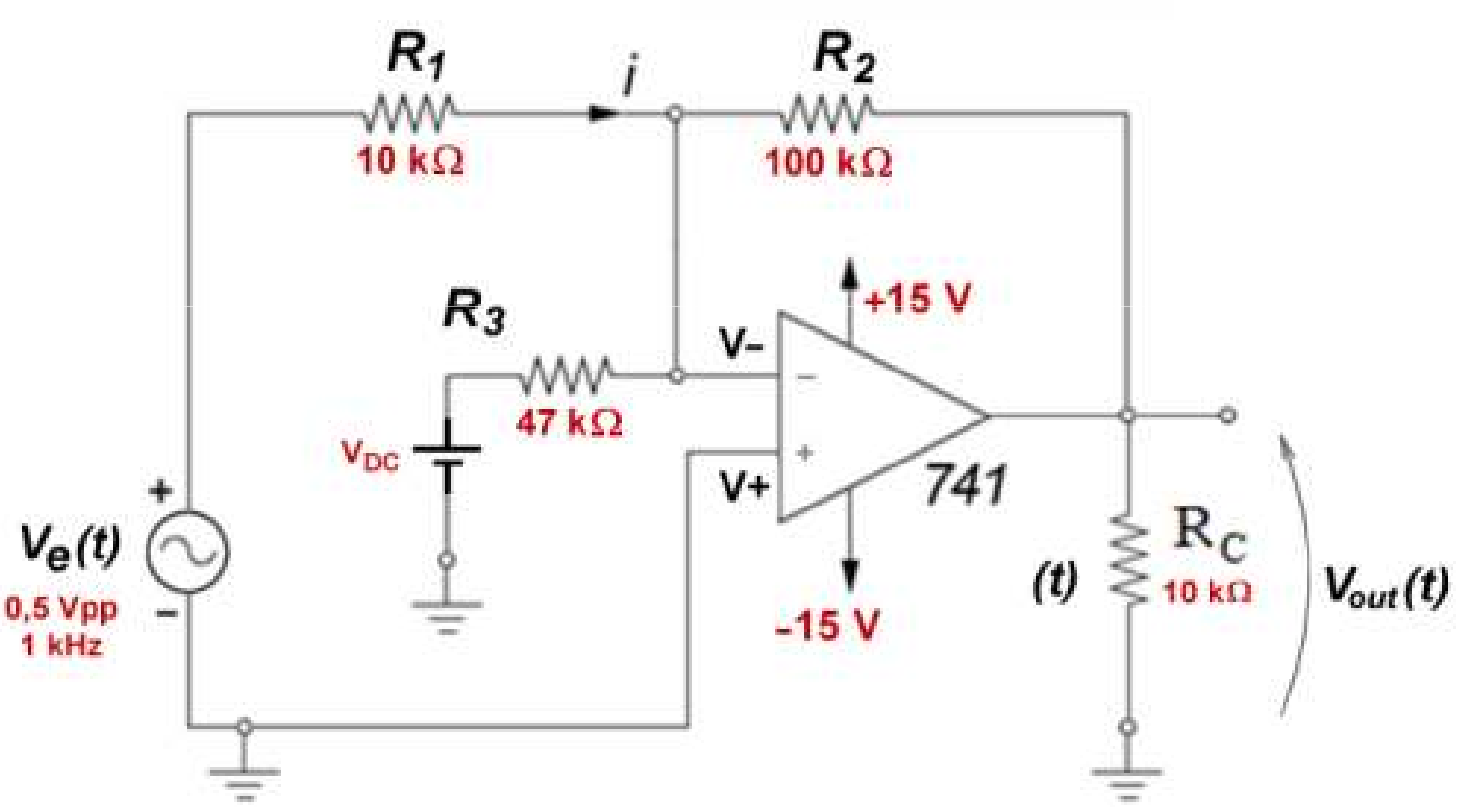


(a) Circuito amplificador inversor com operacional

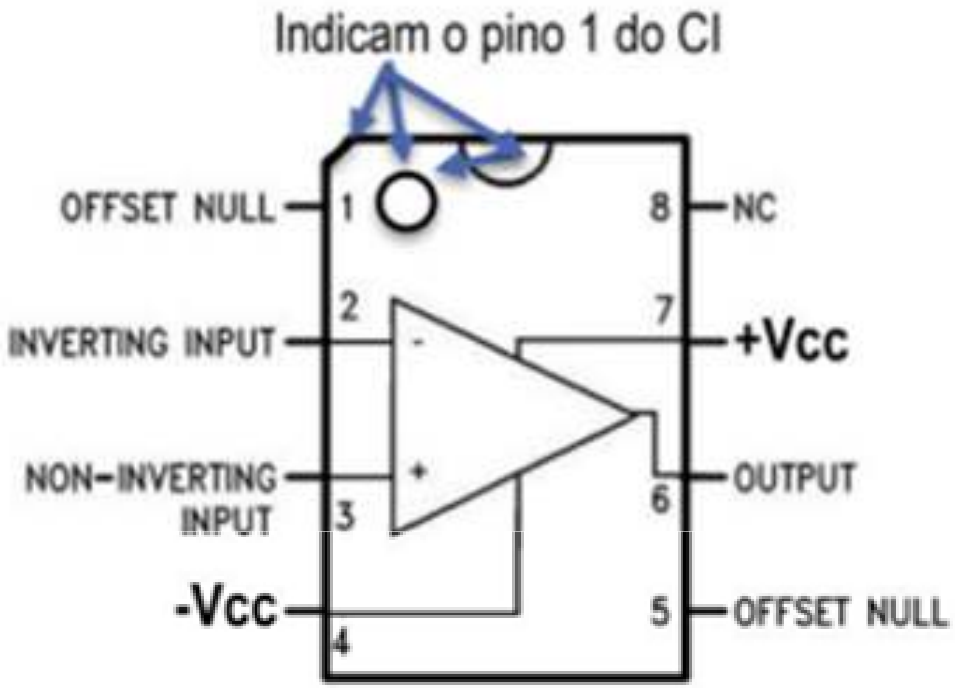


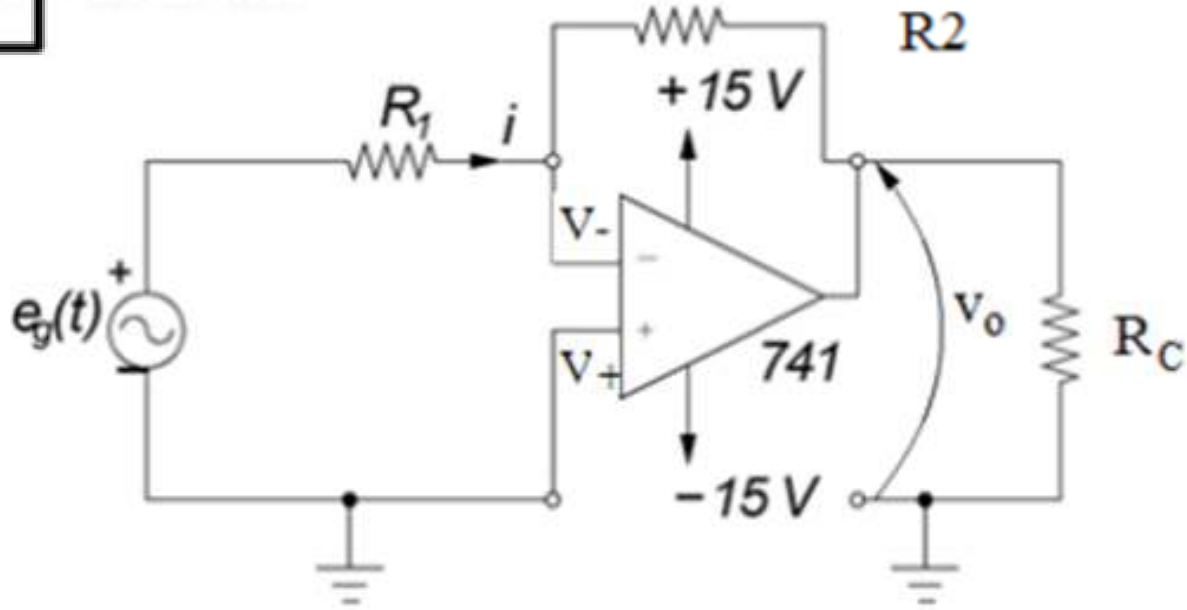
(b) pinagem do 741

Circuito Somador Inversor AC + DC

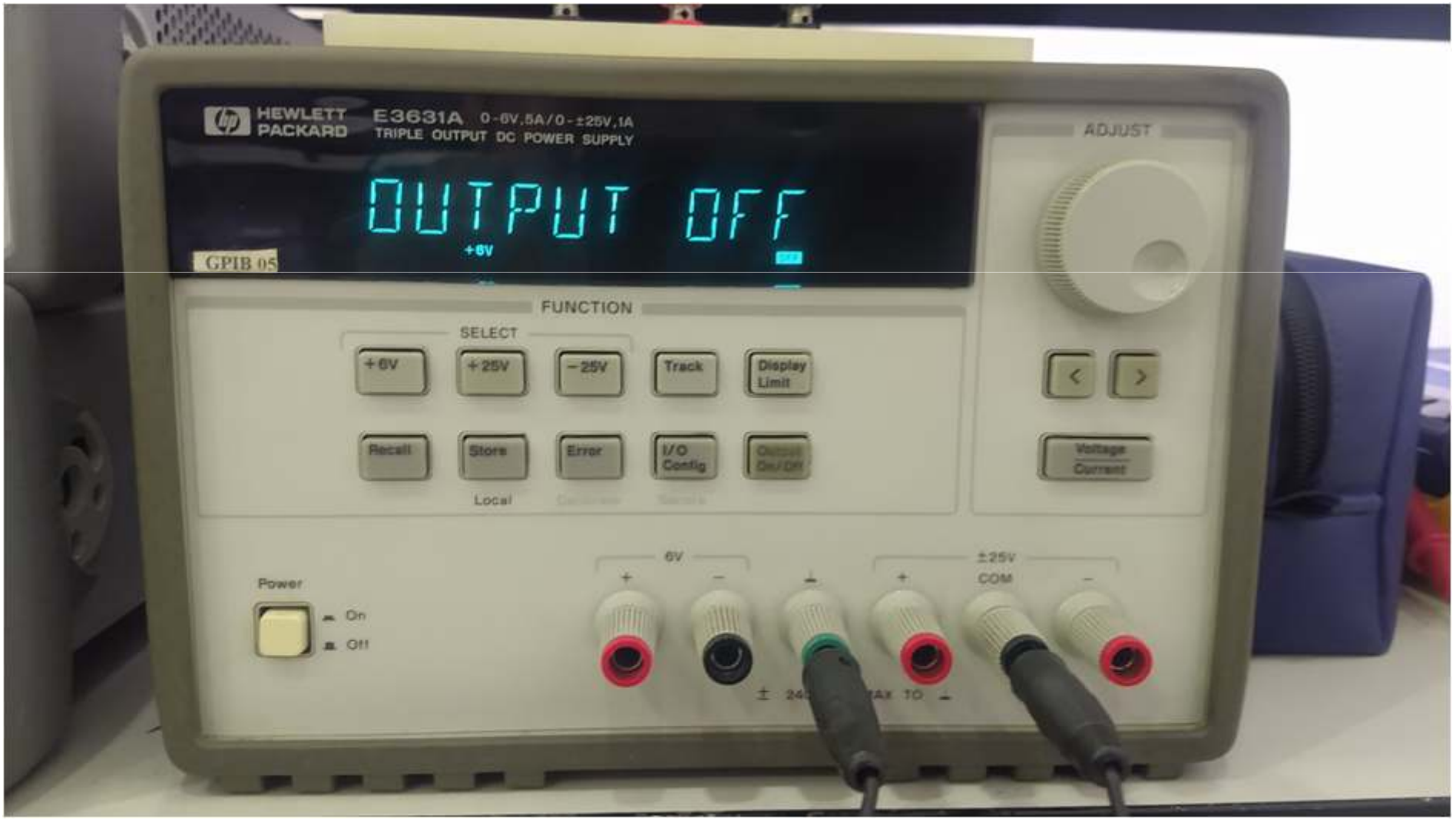


Pinagem do 741

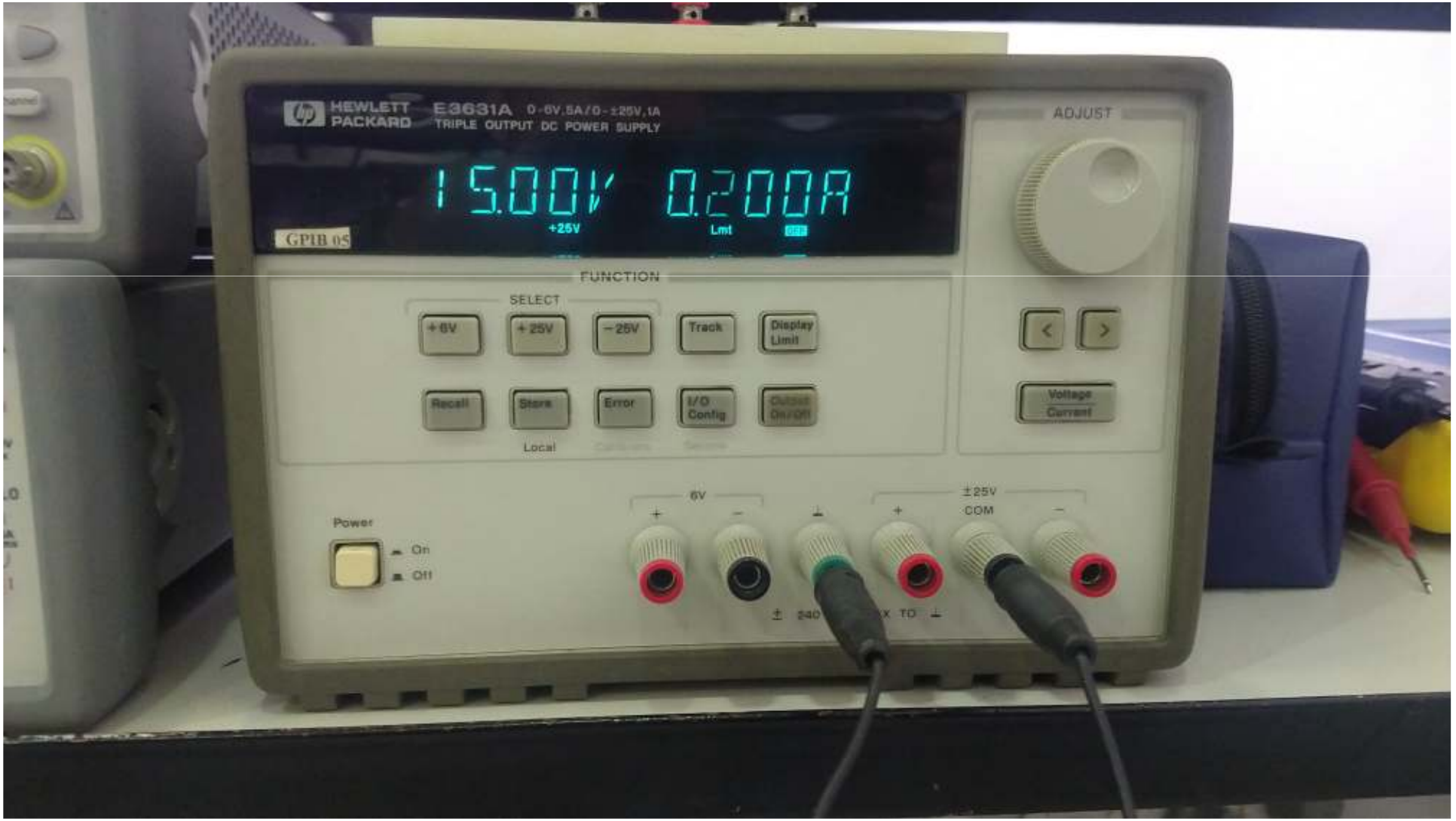




Fonte DC

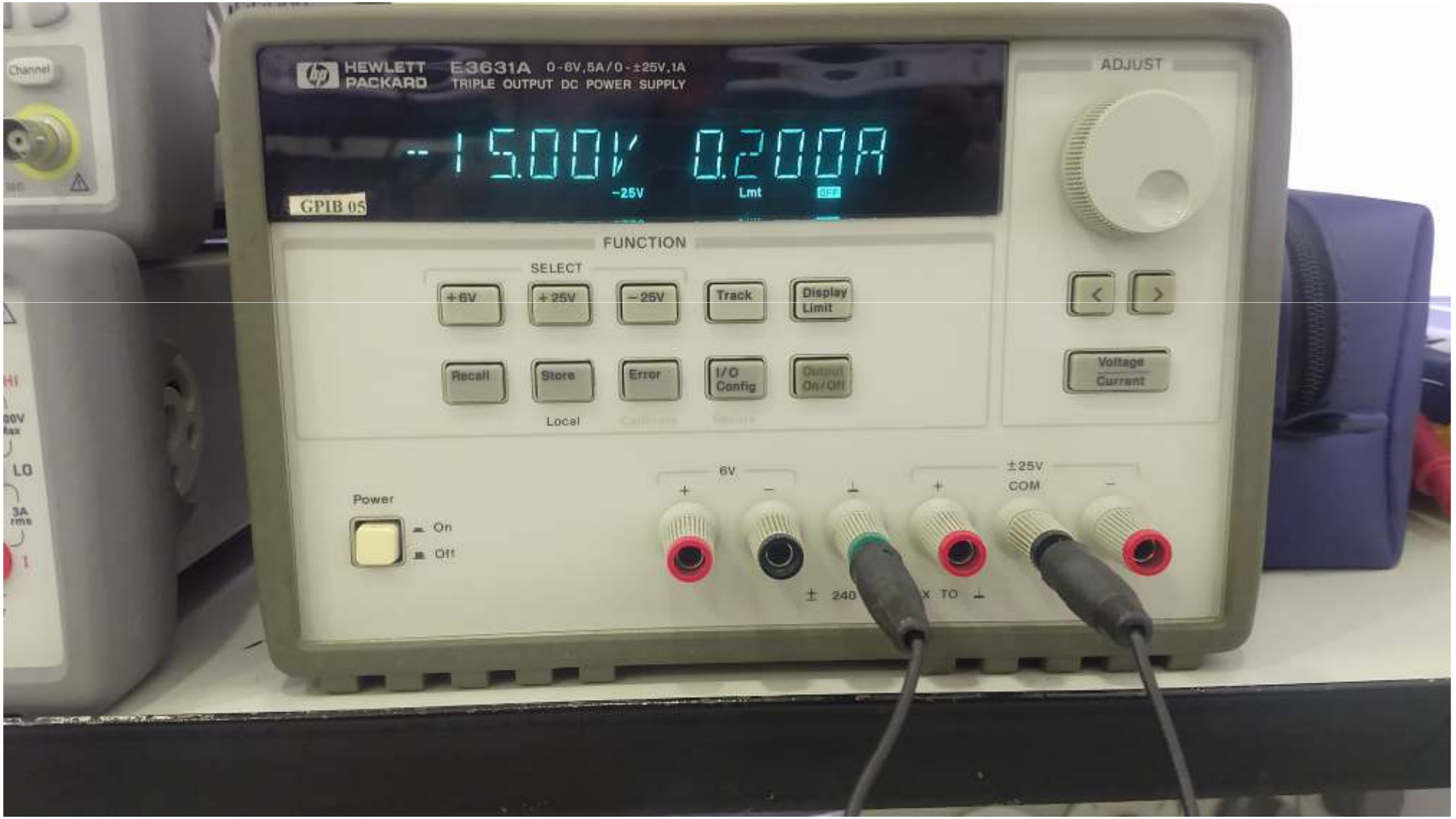

HEWLETT PACKARD
E3631A 0-6V,5A/0-±25V,1A
TRIPLE OUTPUT DC POWER SUPPLY
OUTPUT OFF
+6V
GPIB 05
ADJUST
FUNCTION
SELECT
+6V
+25V
-25V
Track
Display Limit
Recall
Store
Error
I/O Config
Local
Voltage Current
Power
On
Off
6V
±25V
COM

Fonte DC Ajuste +15V e 0,2 A

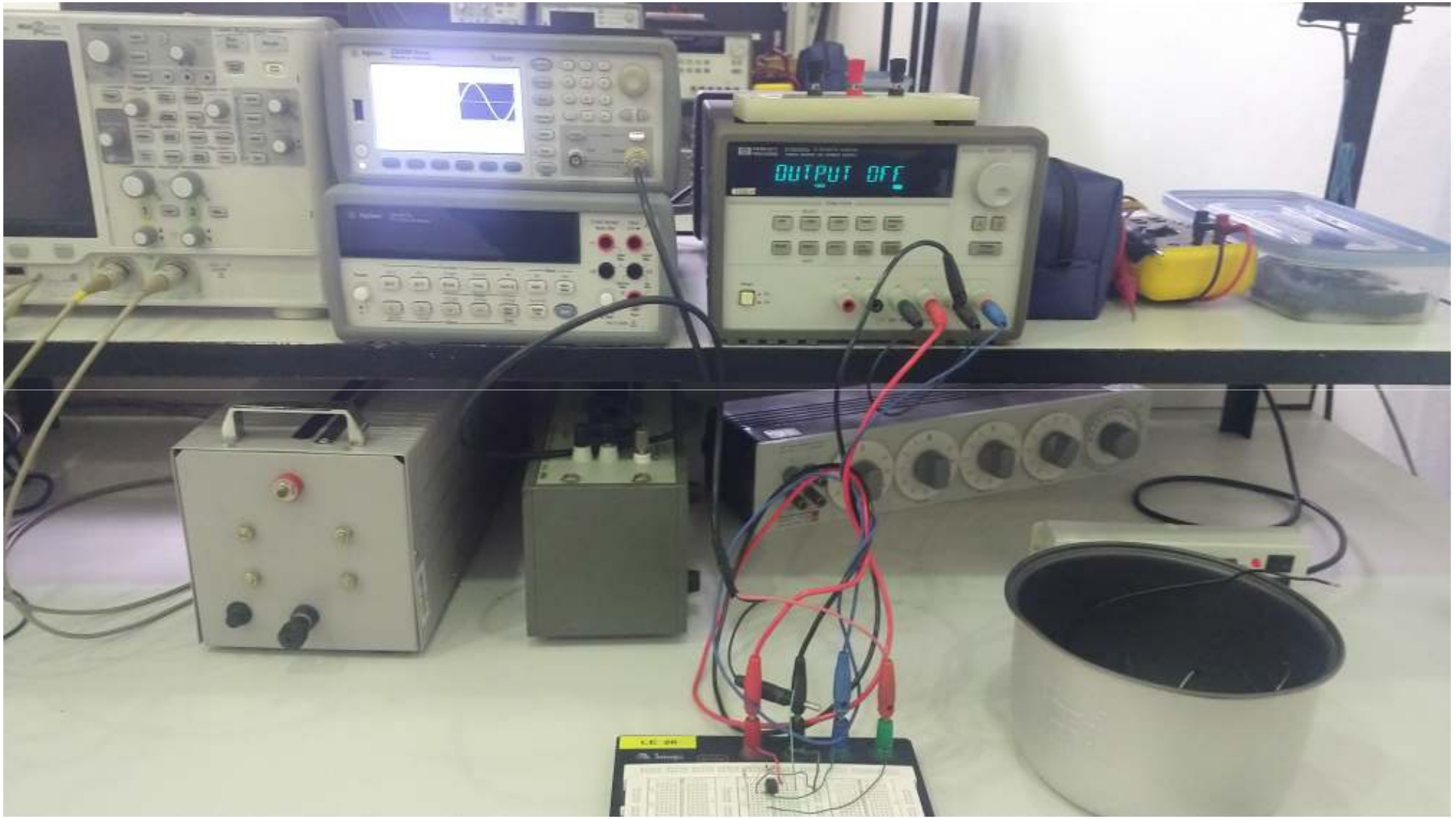


Fonte DC Teclas p Ajuste da tensão

Fonte DC Ajuste -15V e 0,2 A



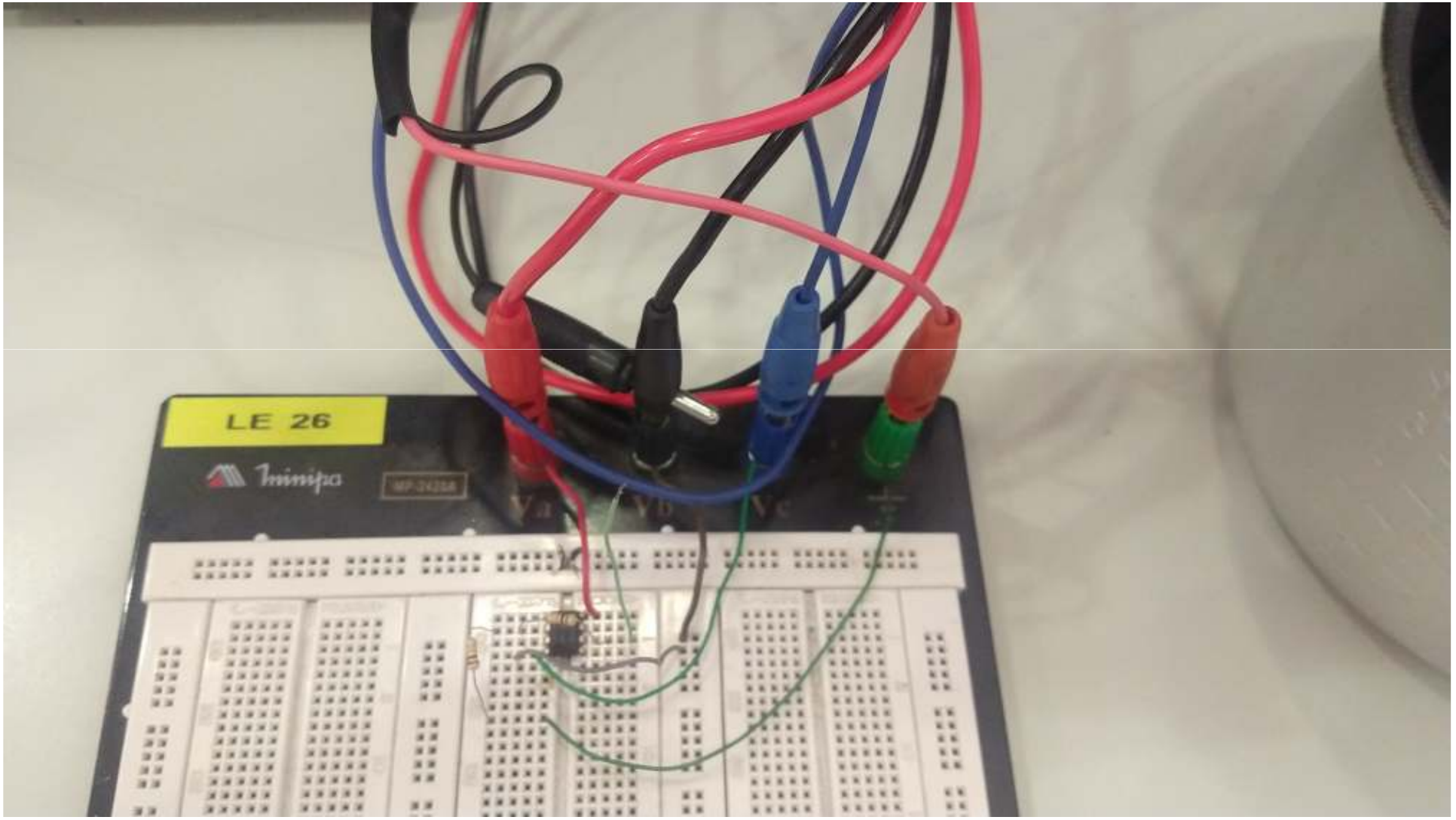
Montagem do circuito



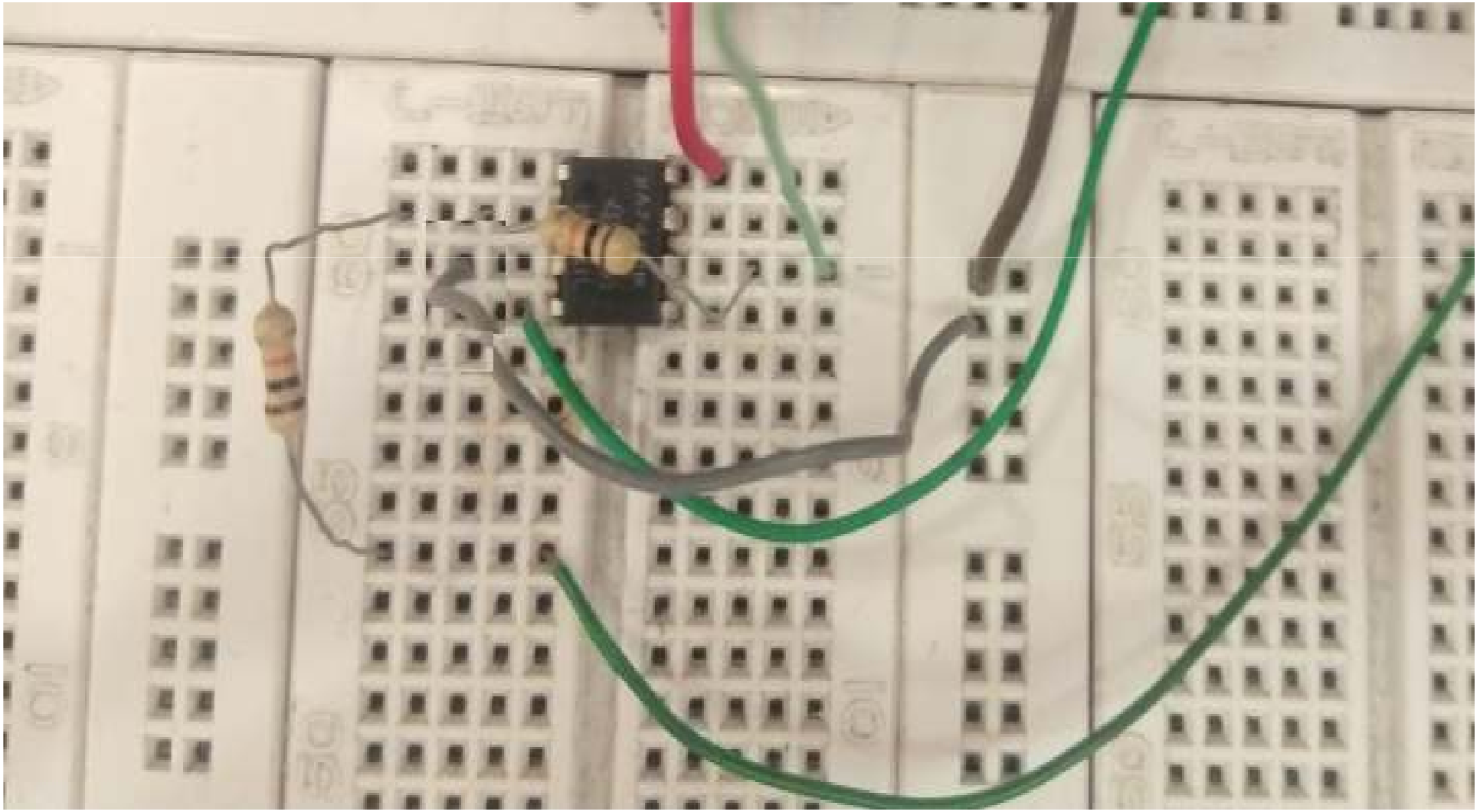
Terra = preto **positivo = vermelho** **negativo = azul**

Nunca colocar saída gerador na saída da fonte DC

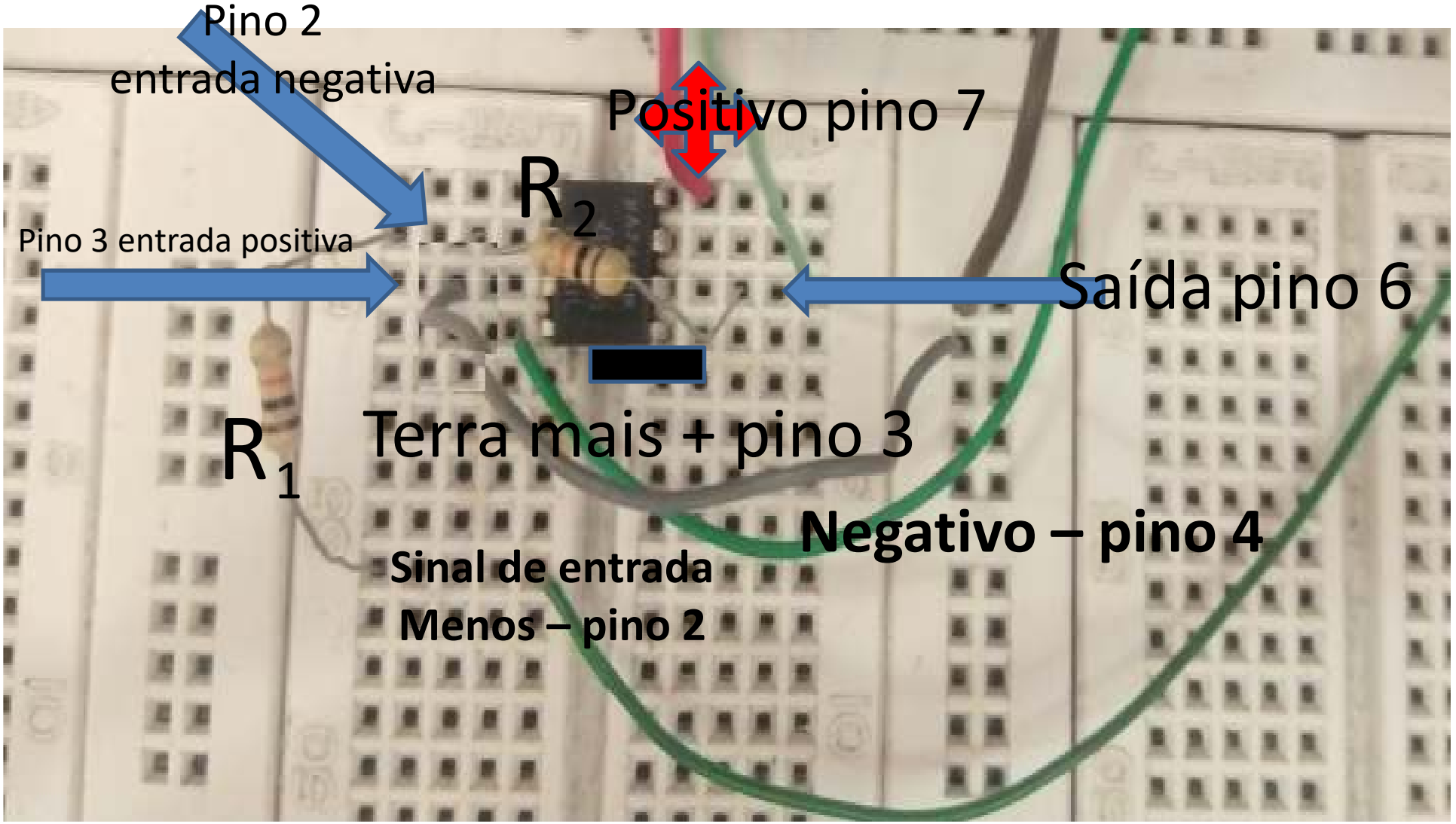
Circuito Amplificador



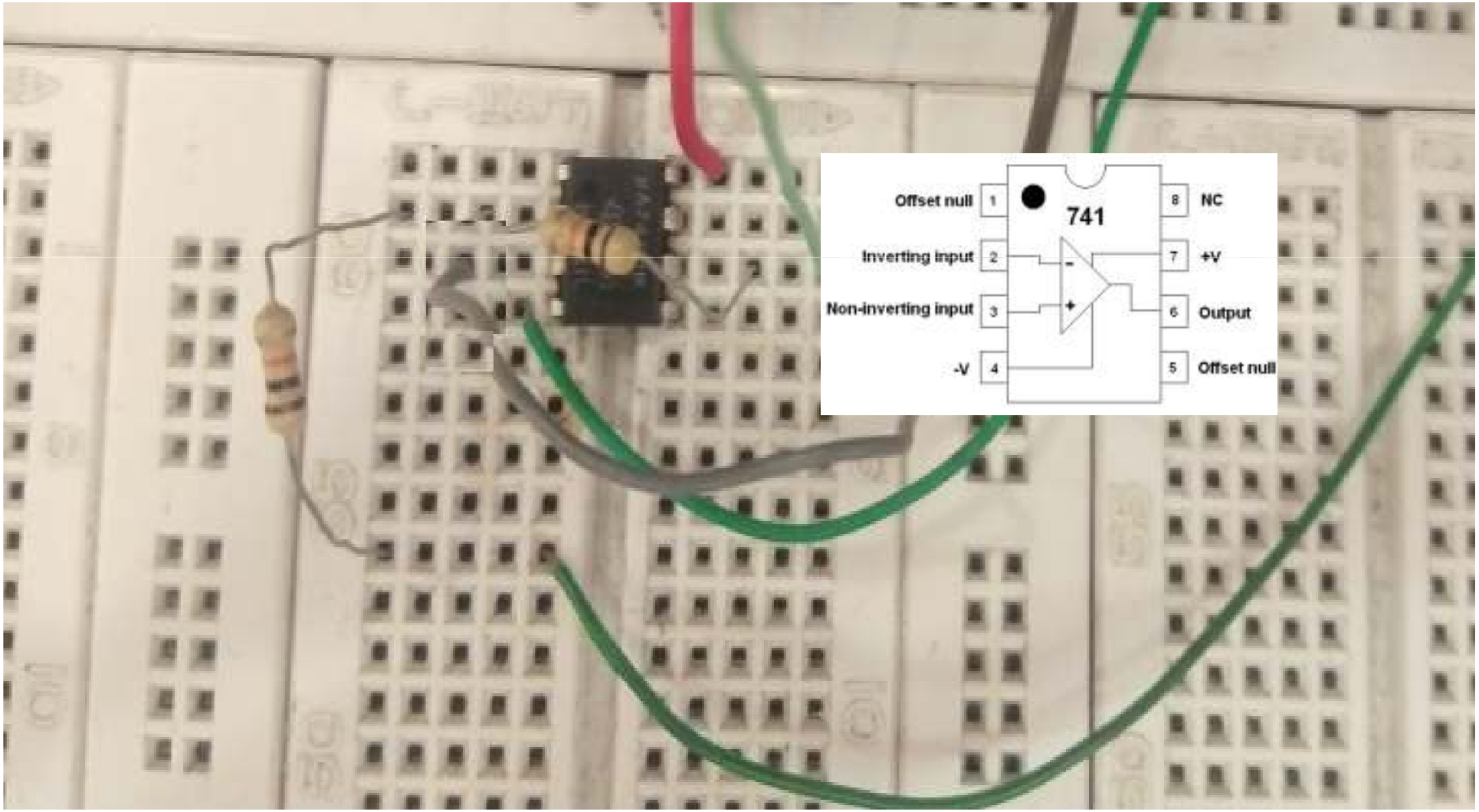
Circuito Amplificador



Circuito Amplificador



Circuito Amplificador



Ao terminar a experiência deixar a bancada em ordem!!!

Boa experiência !!!!

CIRCUITO INTERNO DE UM AMPLIFICADOR OPERACIONAL

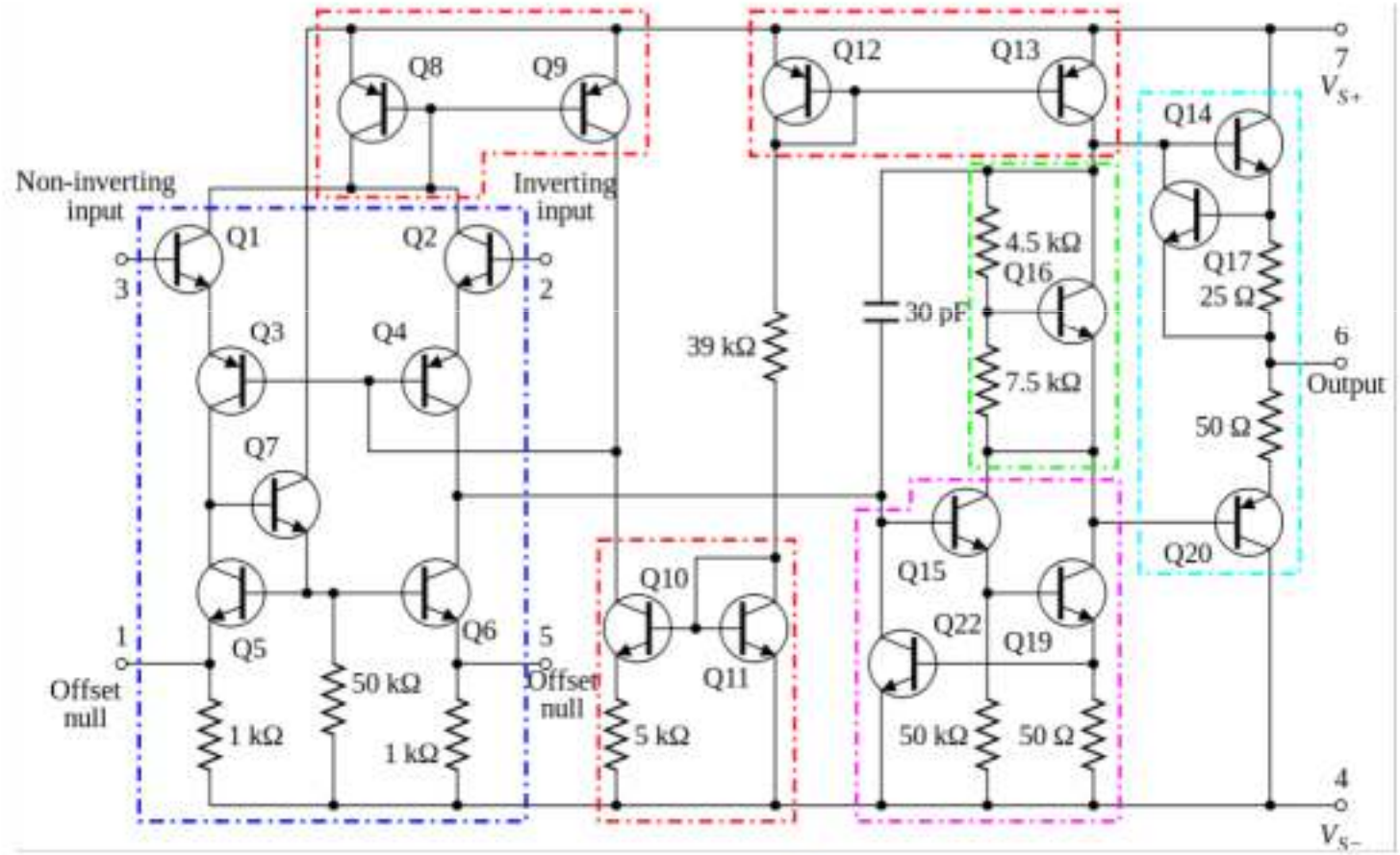


Figura 6 – Diagrama elétrico do AmpOp 741 (Fairchild).