Materiais Elétricos e Magnéticos para Engenharia

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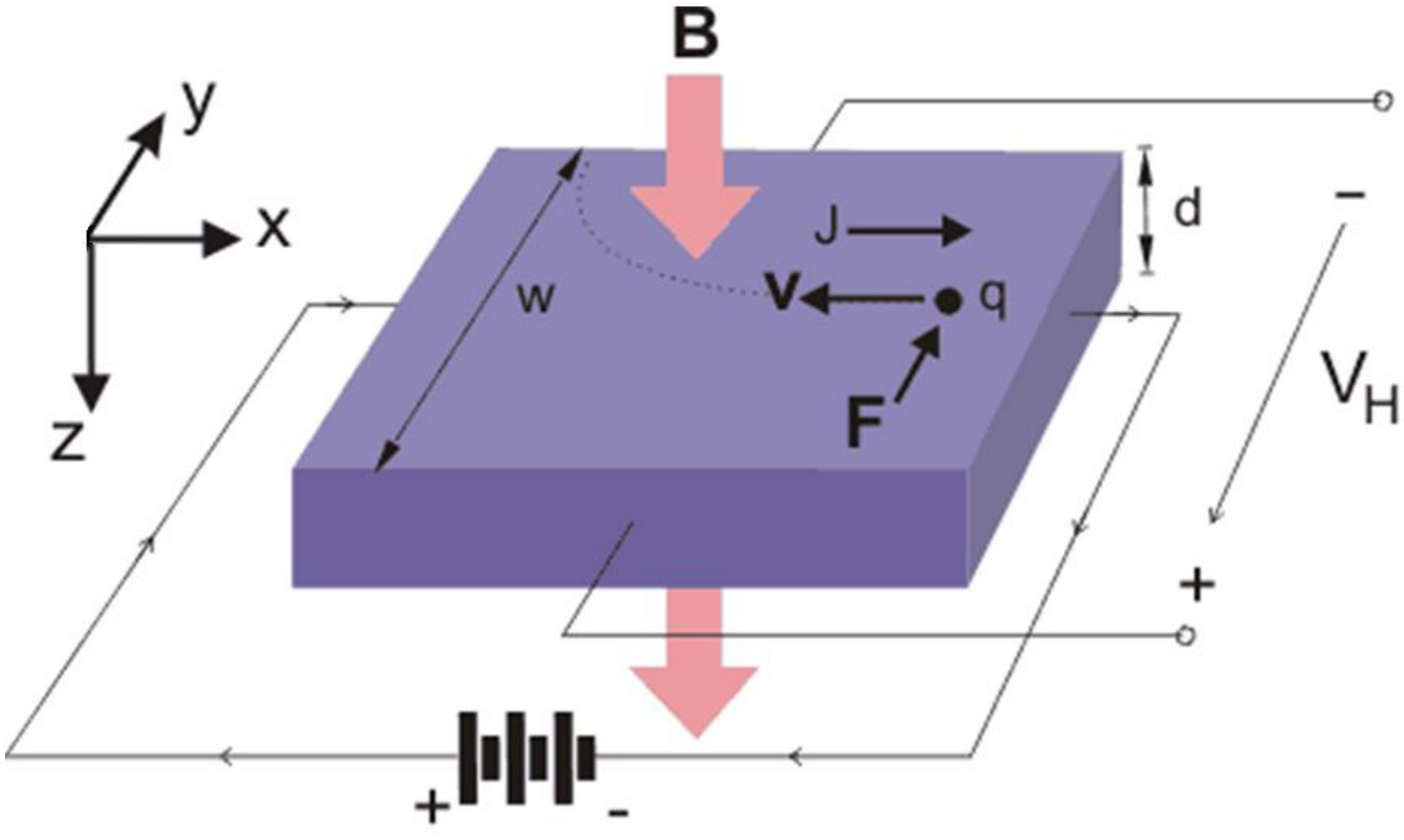
Laboratório #5

Sensor Hall

1º Semestre de 2018

FGA - Universidade de Brasília

Efeito Hall



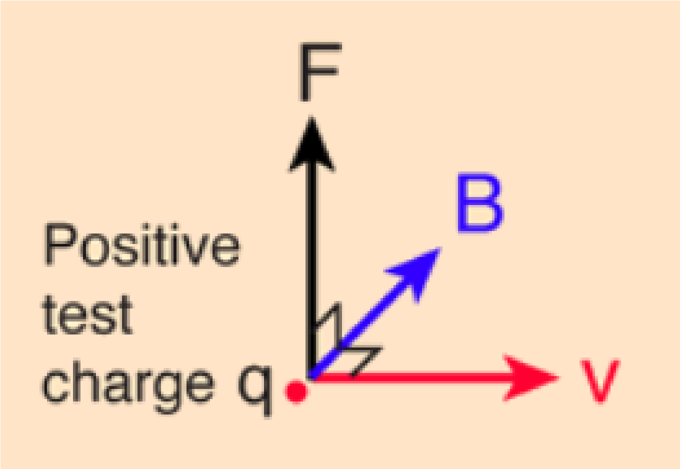
Força de Lorentz

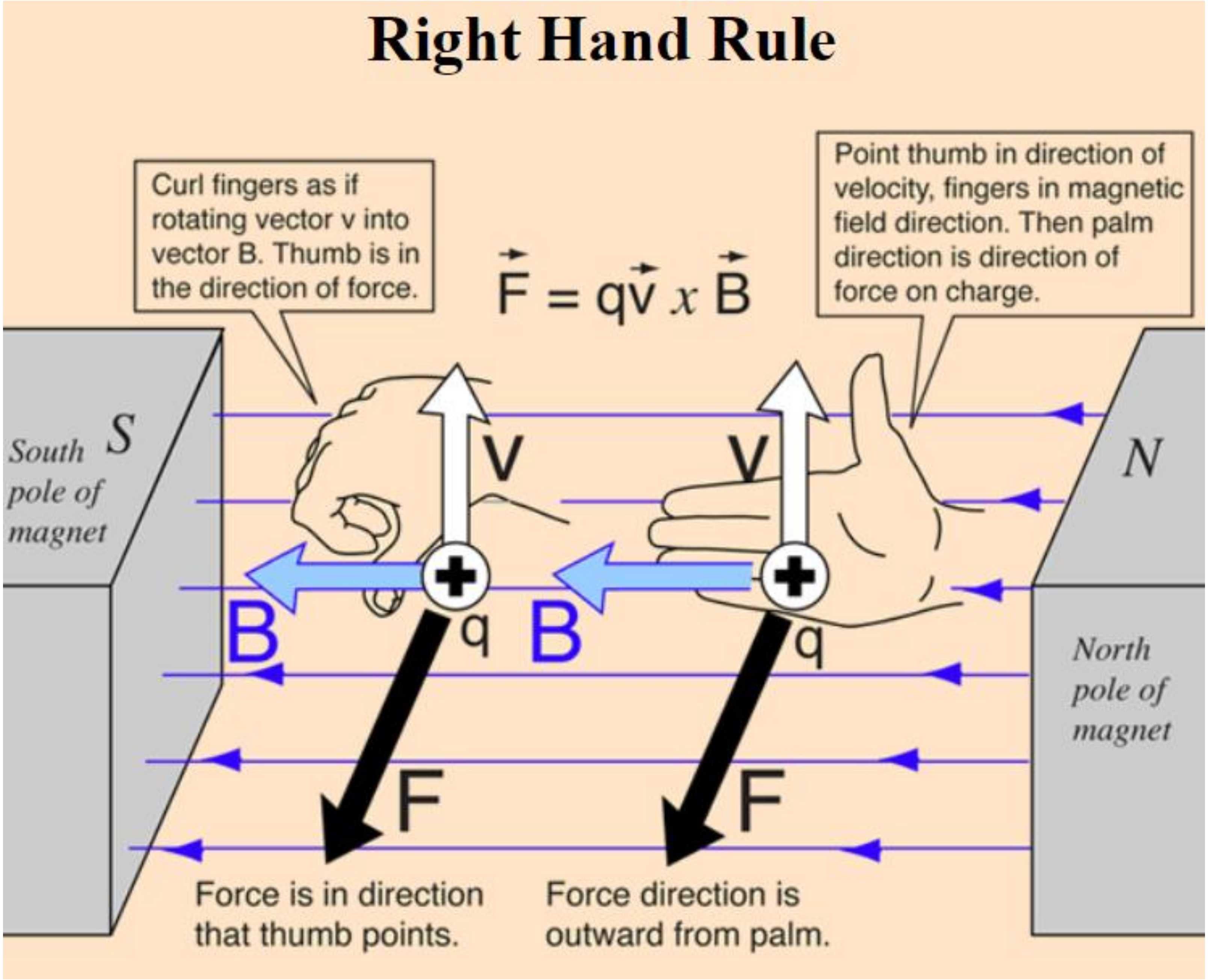
$$\boxed{\mathbf{F} = q(\mathbf{E} + \mathbf{v} \times \mathbf{B})}$$

$$F_x = q(E_x + v_y B_z - v_z B_y)$$

$$F_y = q(E_y + v_z B_x - v_x B_z)$$

$$F_z = q(E_z + v_x B_y - v_y B_x)$$



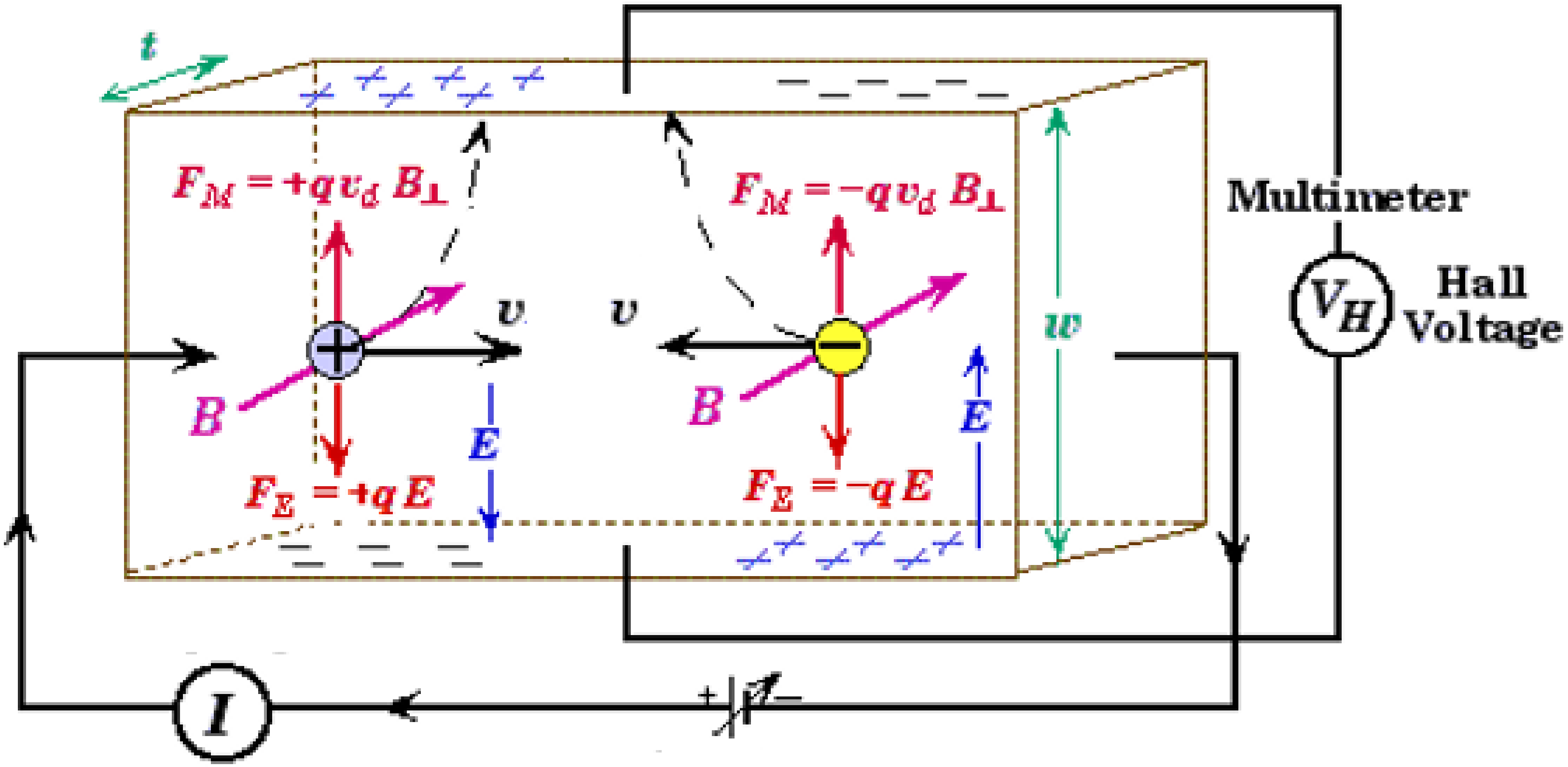


http://hyperphysics.phy-astr.gsu.edu/hbase/magnetic/magfor.html

Efeito Hall

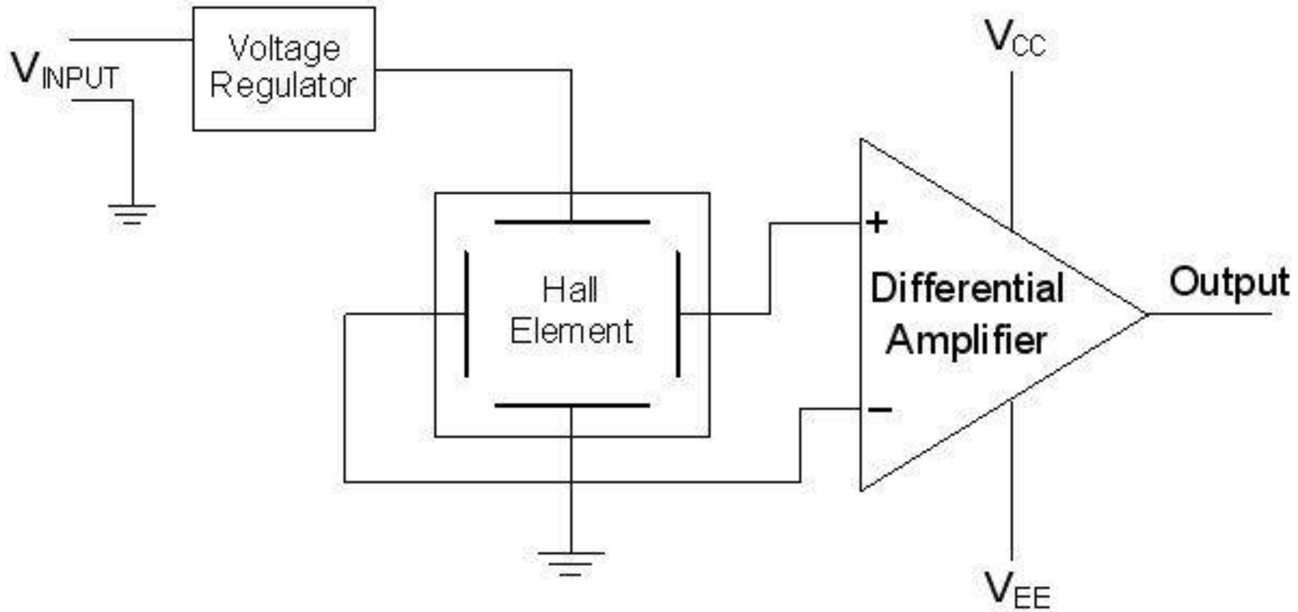
$$\boxed{p_0 + N_D^+ = n_0 + N_A^-}$$

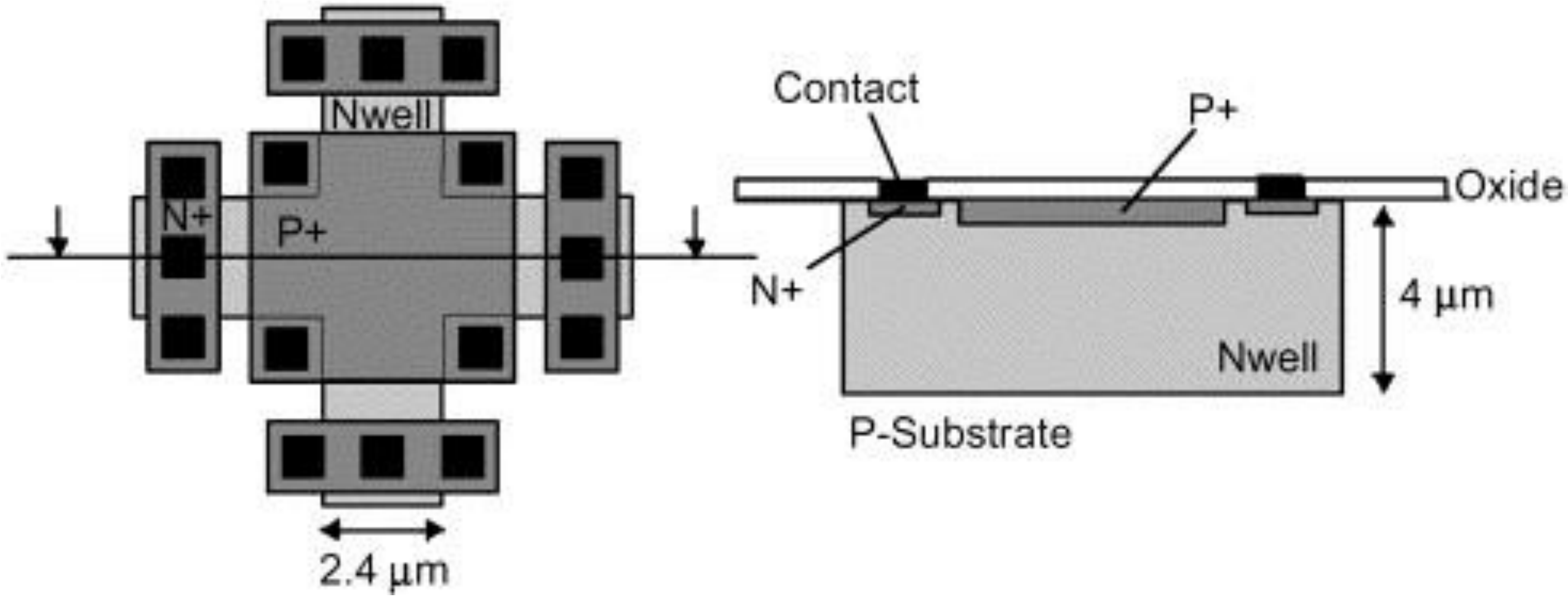
$$V_H = R_H J_P B_z$$



$$R_H = \frac{p\mu_h^2 - n\mu_e^2}{e(p\mu_h + n\mu_e)^2}$$

Sensor Hall Integrado





Densidade de Fluxo Magnético Terrestre

Intensidade: 25 to 65 µT (0.25 to 0.65 G)

1 tesla = 10.000 gauss

$$\mathrm{T} = \mathrm{V{\cdot}s{\cdot}m^{-2}} = \mathrm{N{\cdot}A^{-1}{\cdot}m^{-1}} = \mathrm{Wb{\cdot}m^{-2}} = \mathrm{kg{\cdot}C^{-1}{\cdot}s^{-1}} = \mathrm{kg{\cdot}A^{-1}{\cdot}s^{-2}} = \mathrm{N{\cdot}s{\cdot}C^{-1}{\cdot}m^{-1}}$$

A = ampere	m = meter	T = tesla
C = coulomb	N = newton	V = volt
kg = kilogram	s = second	Wb = weber

31.869 µT (3.1×10^{-5} T) – strength of Earth's magnetic field at 0° latitude, 0° longitude

5 mT – the strength of a typical refrigerator magnet

0.3 T – the strength of solar sunspots

1.25 T – magnetic field intensity at the surface of a neodymium magnet

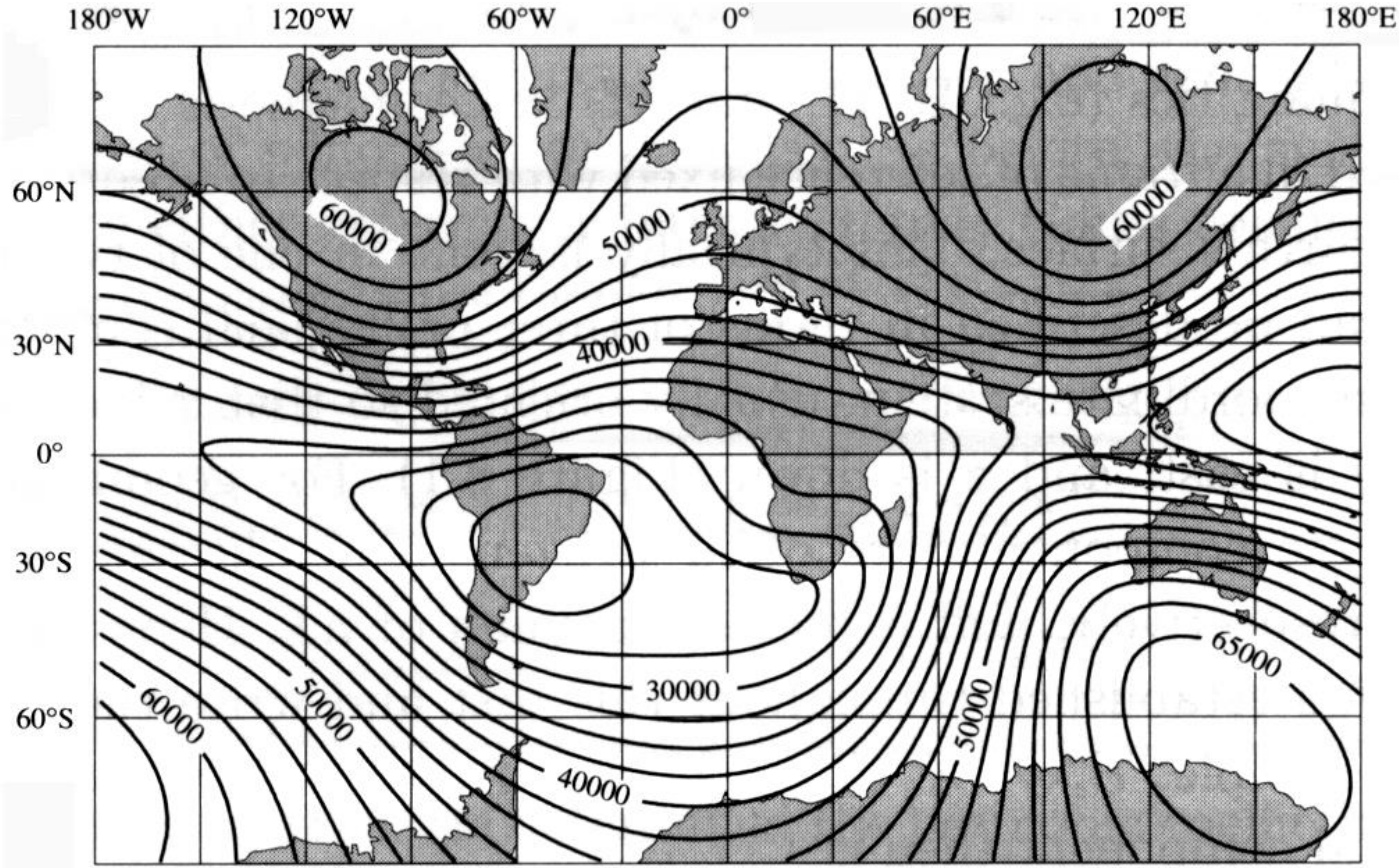
1 T to 2.4 T – coil gap of a typical loudspeaker magnet

1.5 T to 3 T – strength of medical magnetic resonance imaging systems in practice, experimentally up to 17 T

4 T – strength of the superconducting magnet built around the CMS detector at CERN

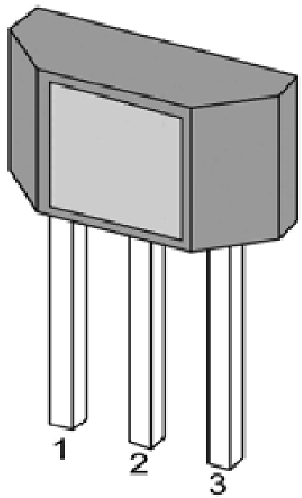
8 T – the strength of LHC magnets.

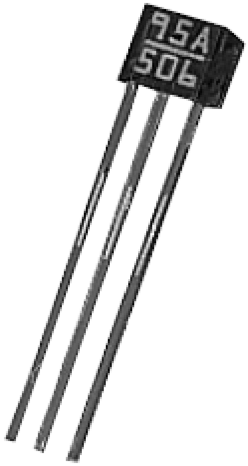
Campo Magnético Terrestre



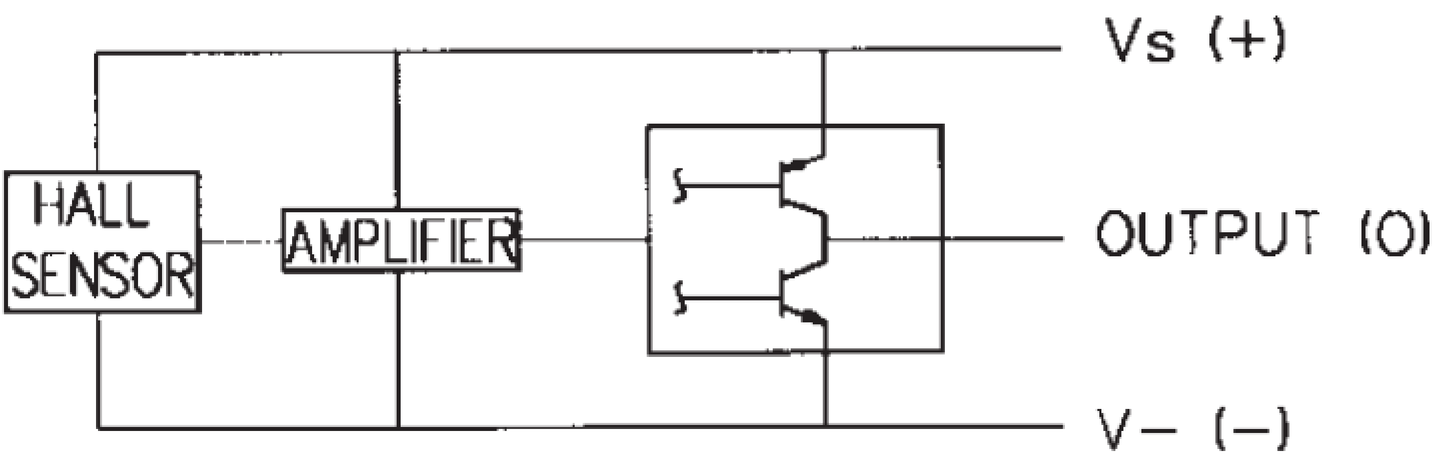
Intensidade em nT (nanotesla)

Sensor Hall (SS495A)





Name	No	Status	Description
Vdd	1	P	Power Supply
Gnd	2	P	IC Ground
Output	3	O	Output



Sensor Hall (SS495A)

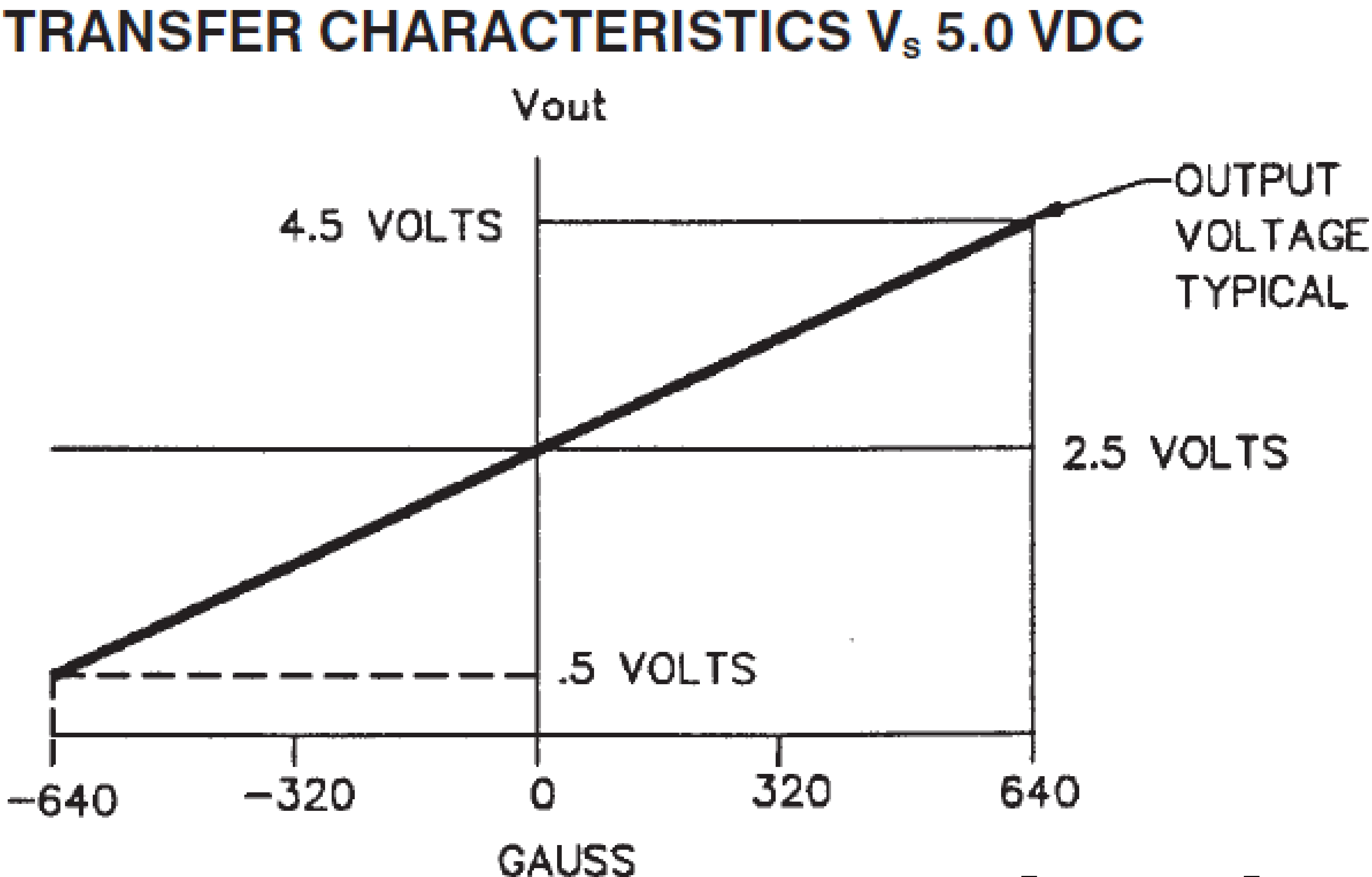
Electrical Characteristics（TA =25℃， VCC =5.0V）

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Operating Voltage	V_{CC}	Operating	4.5	5	10.5	V
Supply Current	I_{CC}	Average		5	8.0	mA
Output Current	I_{OUT}		1.0	1.5		mA
Response Time	Tack			3		uS
Quiescent Output Voltage	Vo	B=0G		2.5		V
Sensitivity	△Vout	T_A=25℃	3.0	3.3	3.6	mV/G
Min Output Voltage		B=-700G		0.2		V
Max Output Voltage		B=700G		4.8		V

Absolute Maximum Ratings

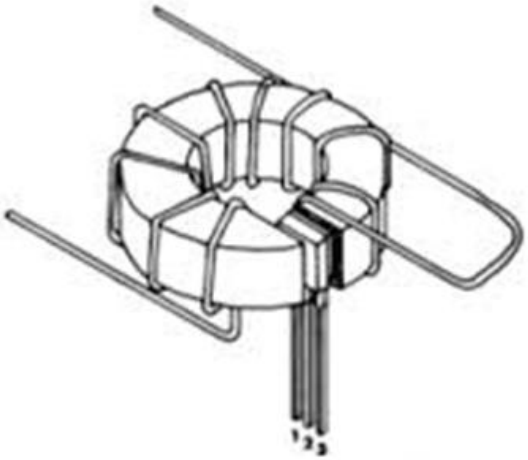
Parameter	Symbol	Value	Units
Supply Voltage (operating)	V_{CC}	10.5	V
Output Current	I_{OUT}	2	mA
Operating Temperature Range	T_A	-40~150	℃
Storage Temperature Range	T_S	-65~150	℃

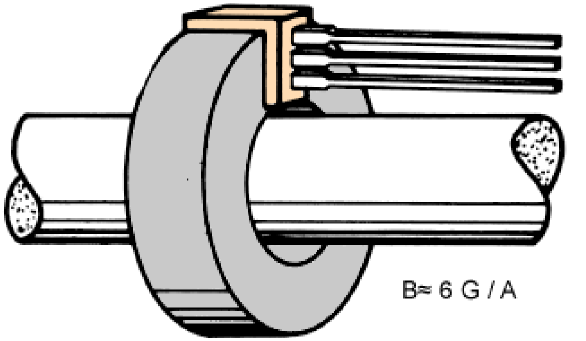
Sensor Hall (SS495A)



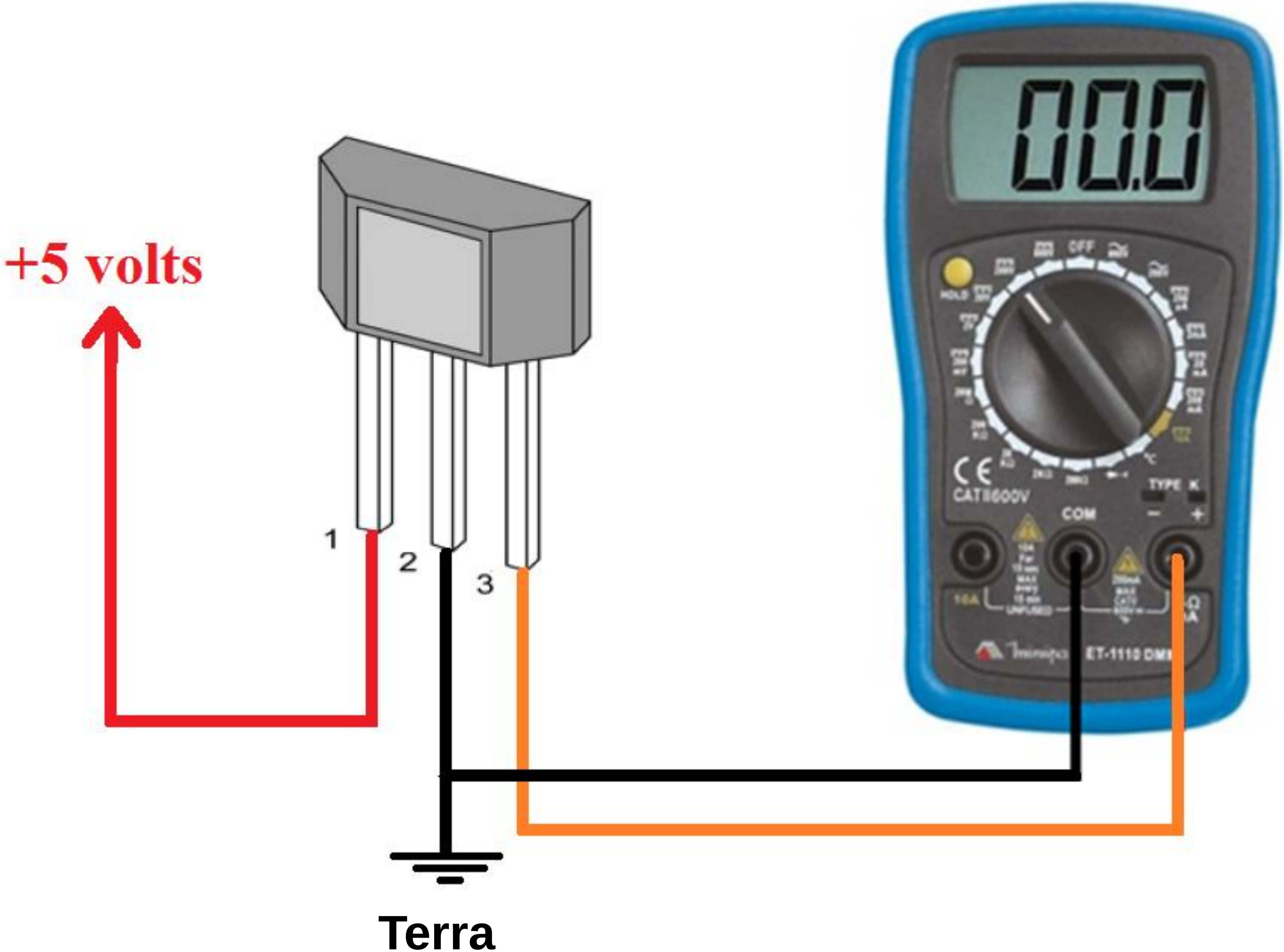
$$3{,}125[mV/G]$$

Tecnologia de Sensores Hall

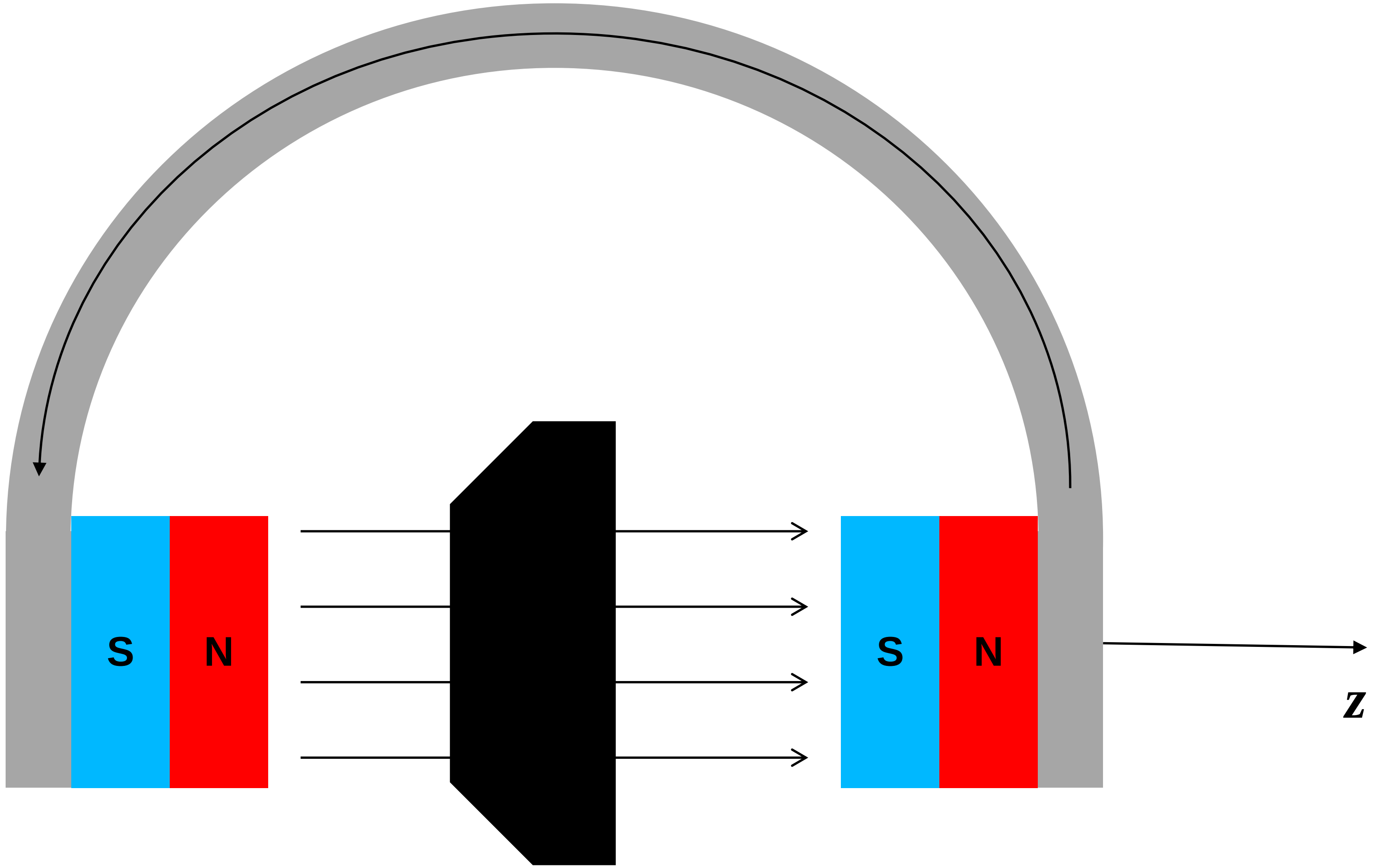




Circuito de Medidas

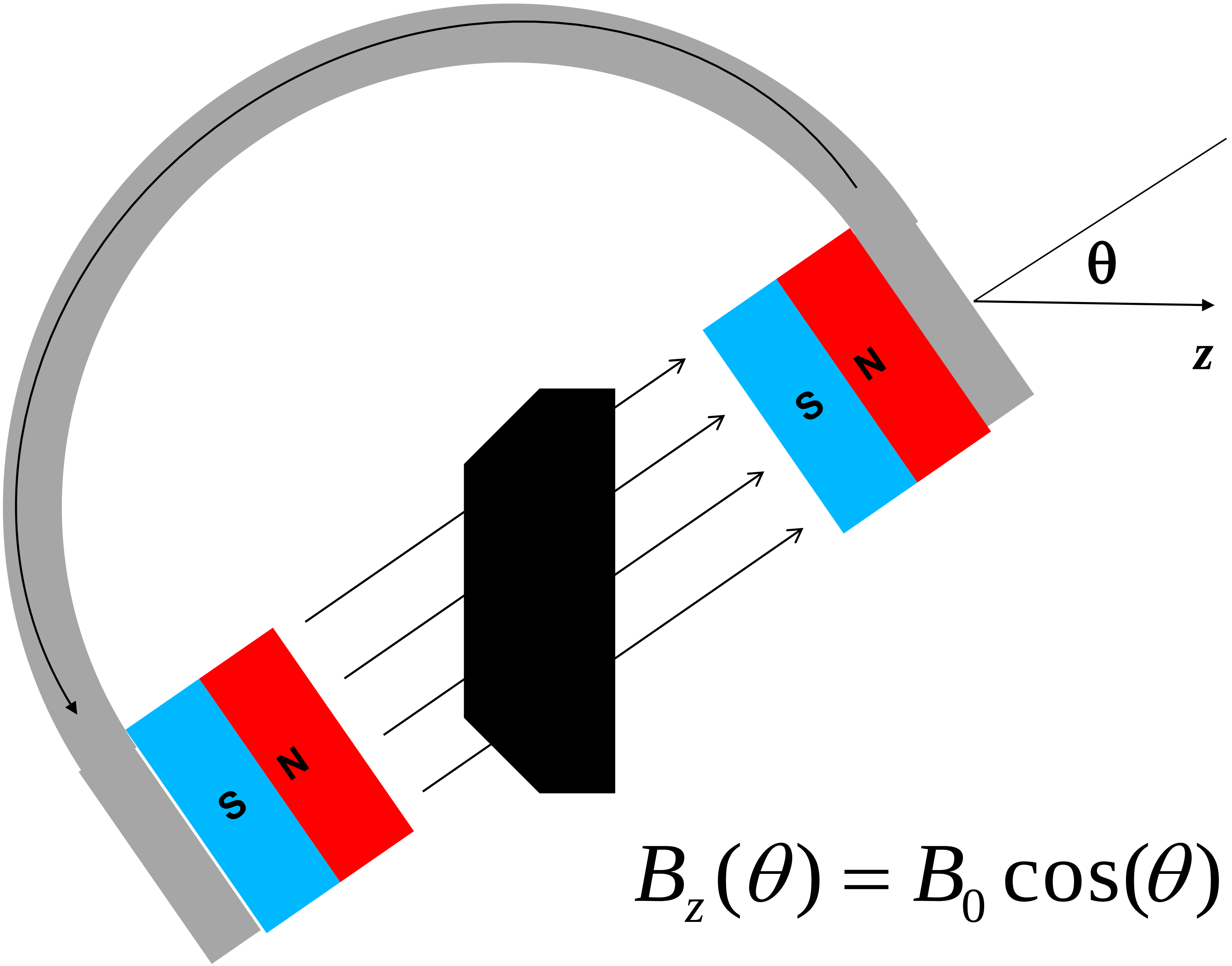


Magneto



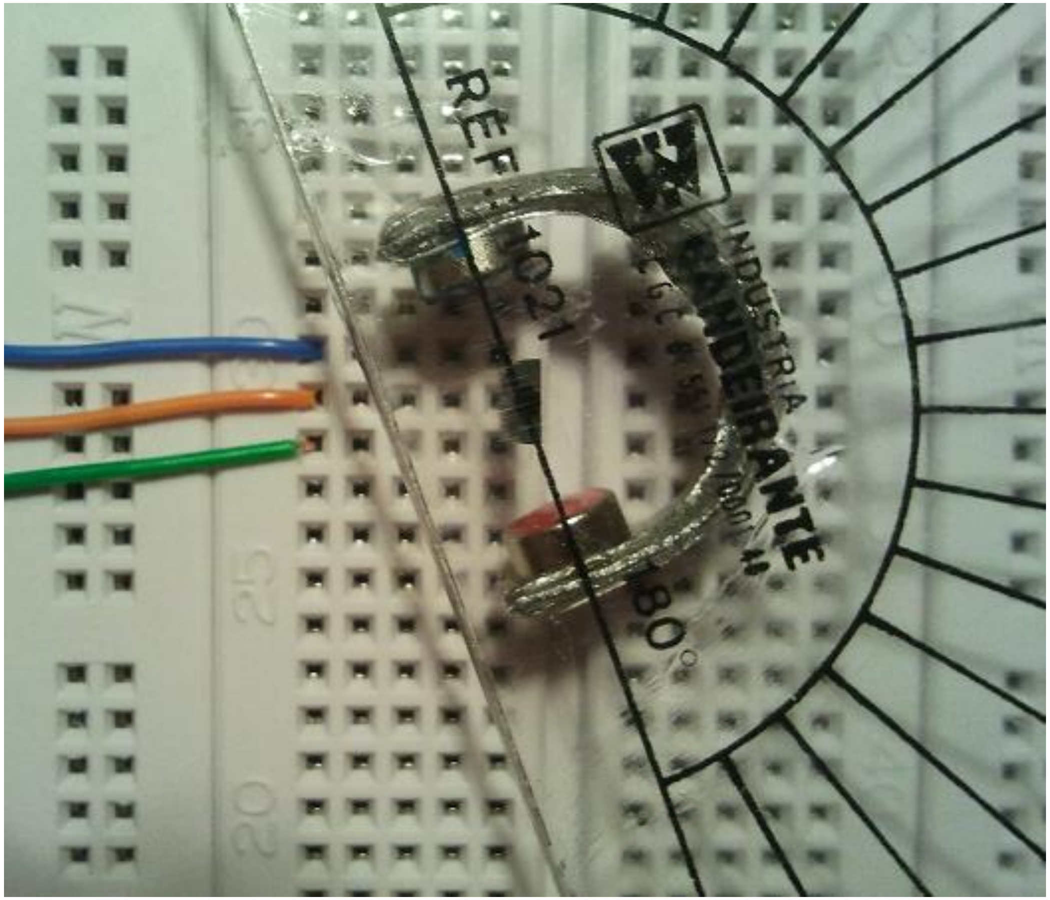
$$B_z = B_0$$

Rotação do Magneto

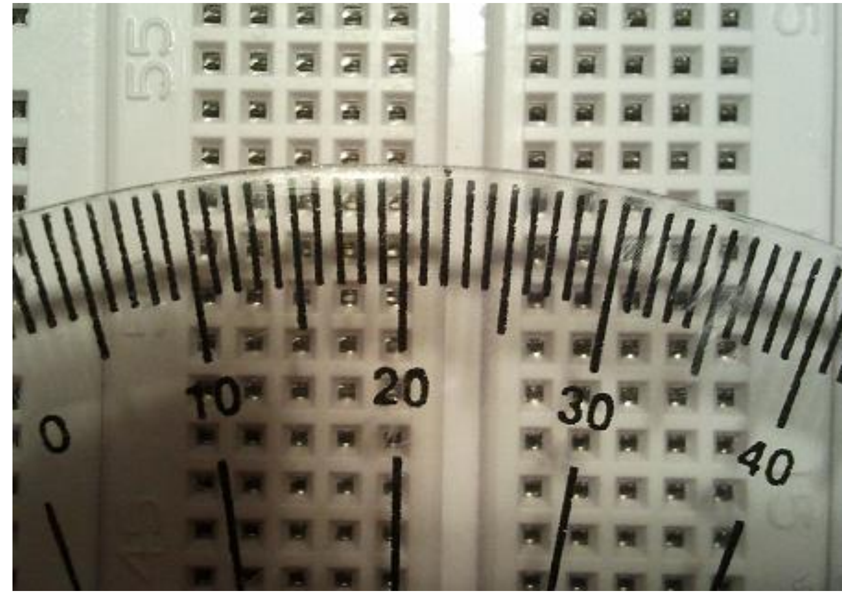


$$B_z(\theta) = B_0 \cos(\theta)$$

Medidas com o Sensor Hall



Transferidor com Magneto em “U”



Modelo Físico

$$B_z(\theta) = B_0 \cos(\theta)$$

$$V_H = \frac{IB_z(\theta)}{ep_0 A} = \frac{J_P B_z(\theta)}{ep_0} = R_H J_P B_z(\theta) = k_H B_z(\theta)$$

Tipo-p

$$V_s = GV_H + V_{so}$$

$$V_{so} = V_s\Big|_{B_z=0}$$

$$V_s = Gk_H B_z(\theta) + V_{so} = Gk_H B_0 \cos(\theta) + V_{so}$$

$$\boxed{V_s = k_s B_0 \cos(\theta) + V_{so}}$$

Determinando B_0

$$\boxed{V_s = k_s B_0 \cos(\theta) + V_{so}}$$

$$\theta = 0 \Rightarrow V_{s\_\max} = k_s B_0 + V_{so}$$

$$\boxed{B_0 = \frac{V_{s\_\max} - V_{so}}{k_s}}$$

$$k_s \cong 3{,}125 [mV / G]$$