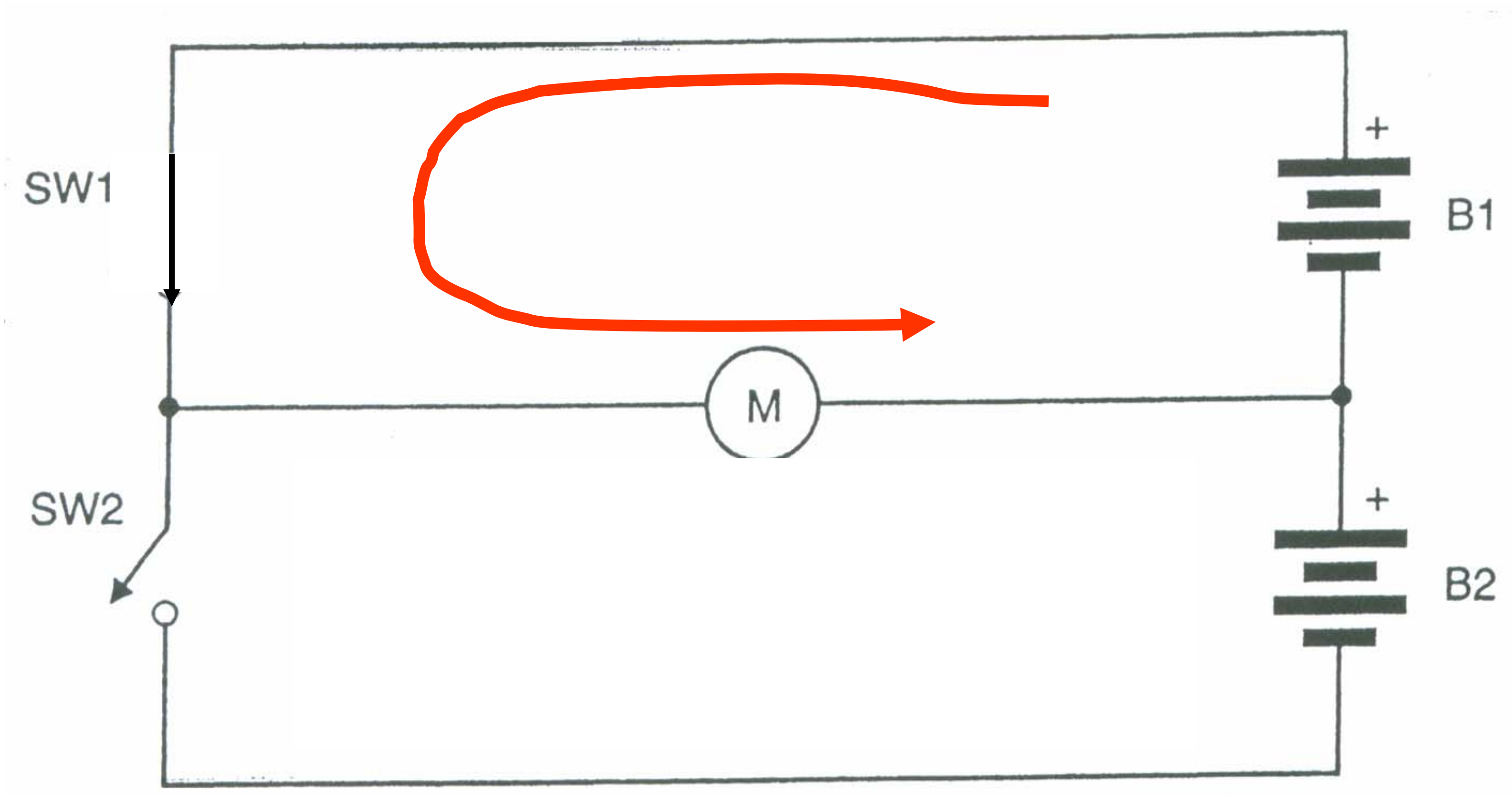
Lecture 16

H-Bridge

DC Motor Direction Control

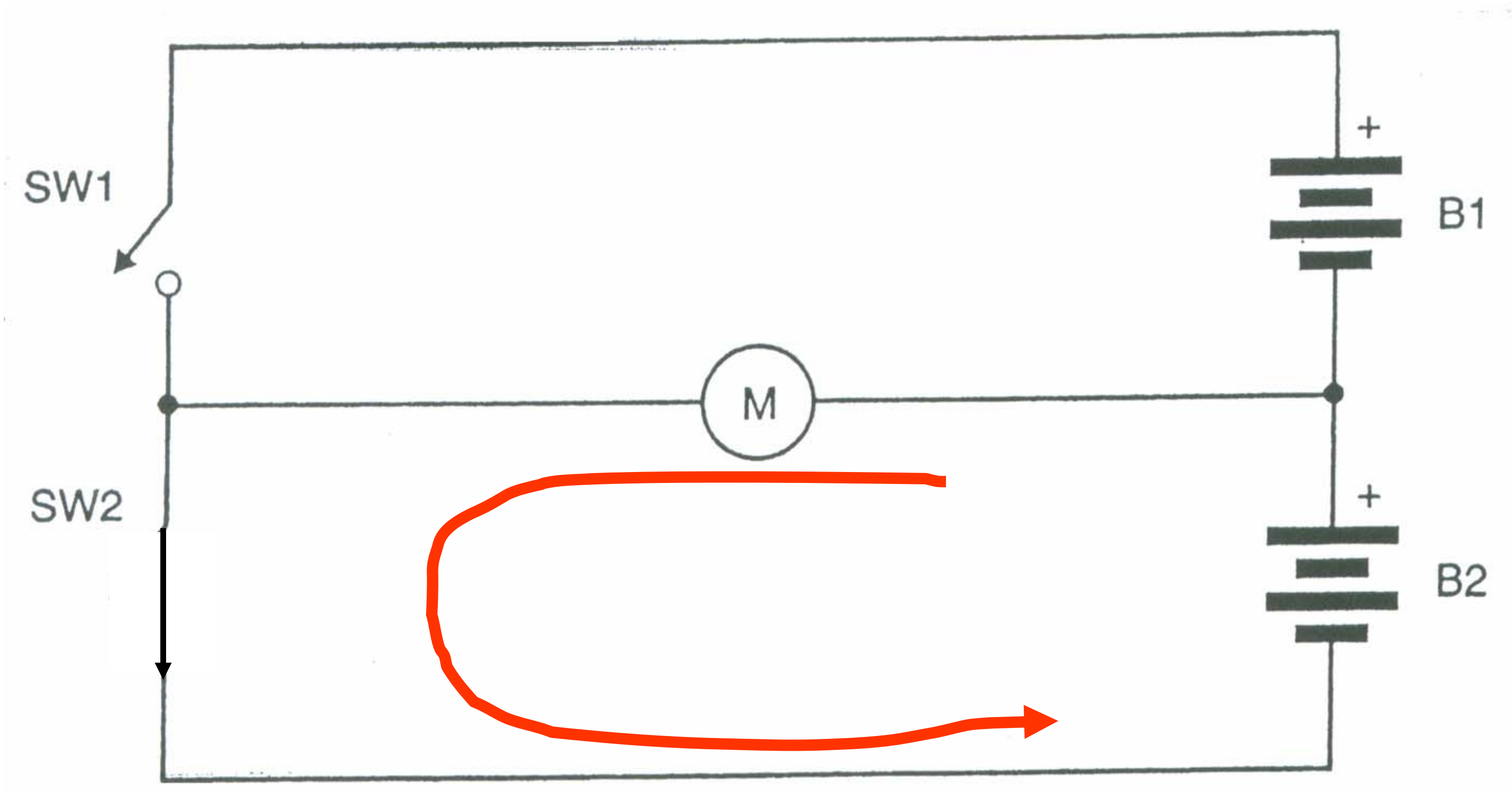
- Half Bridge
  - 2 switches and 2 power sources
- H-Bridge
  - 4 switches and 1 power sources

Half Bridge 1



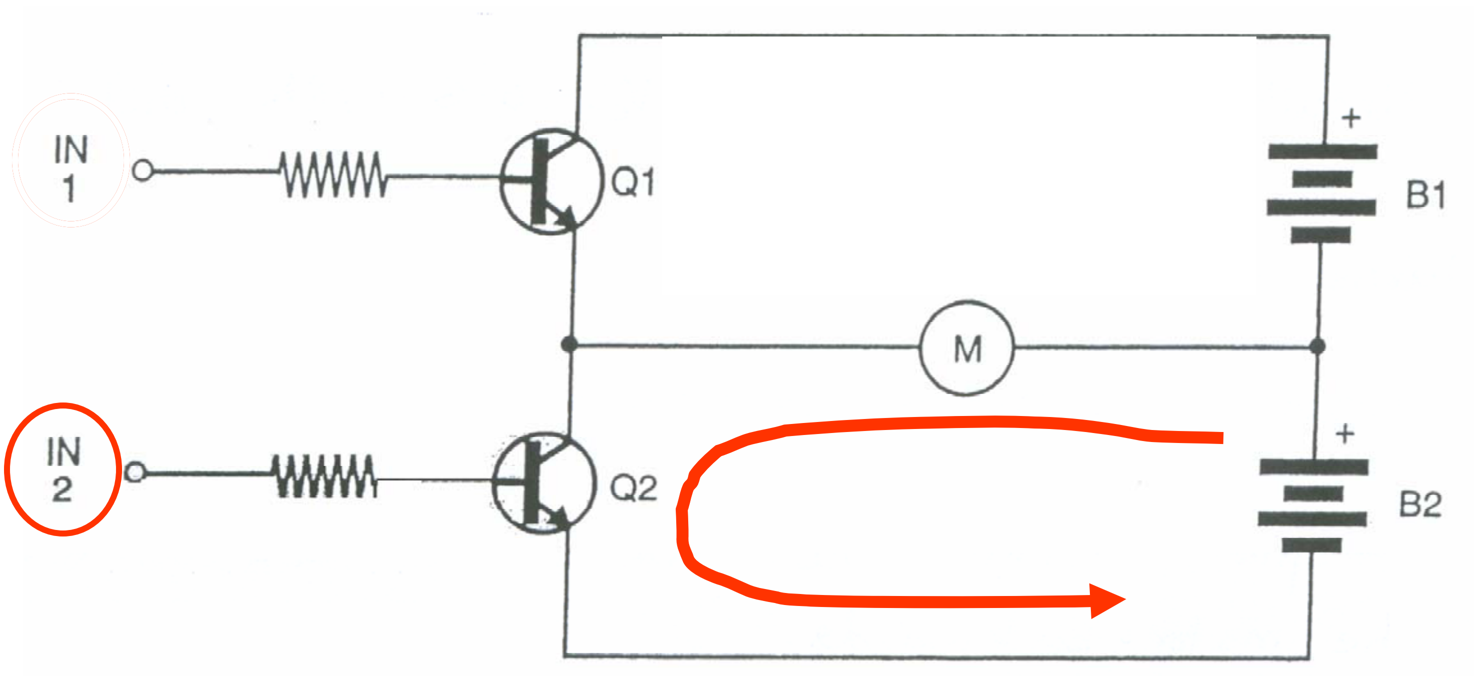
Switch

Half Bridge 1



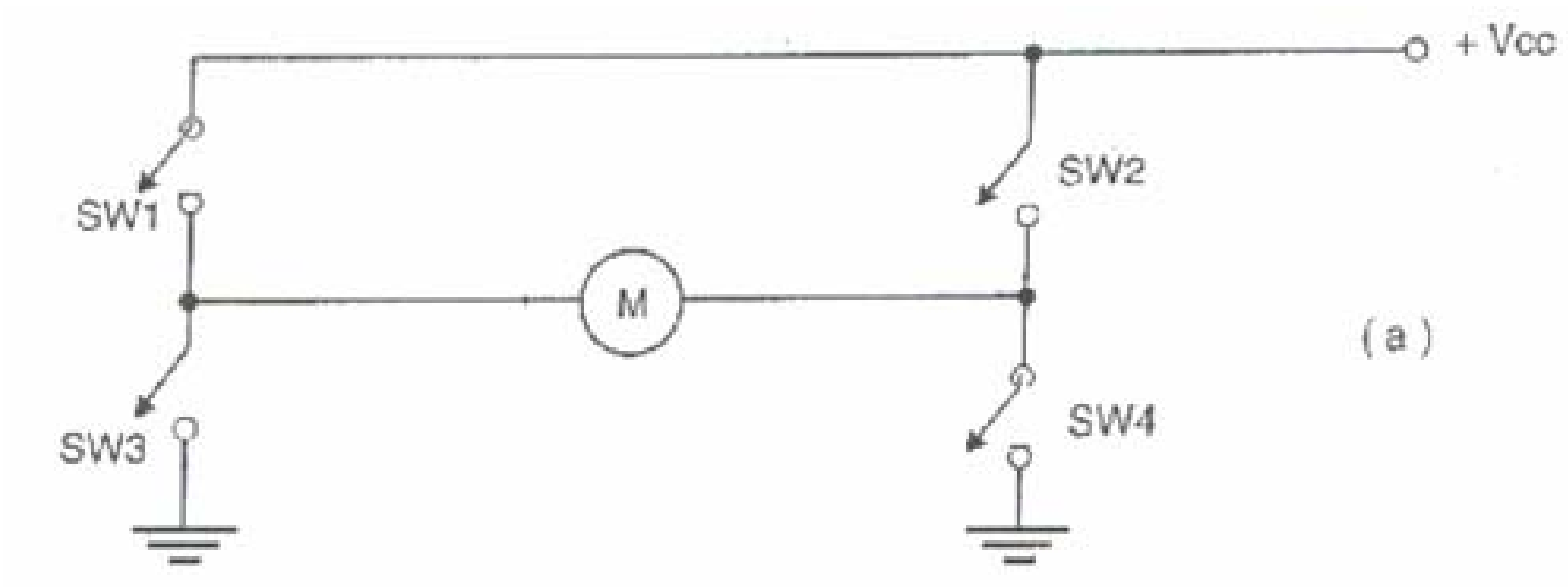
Switch

Half Bridge 2



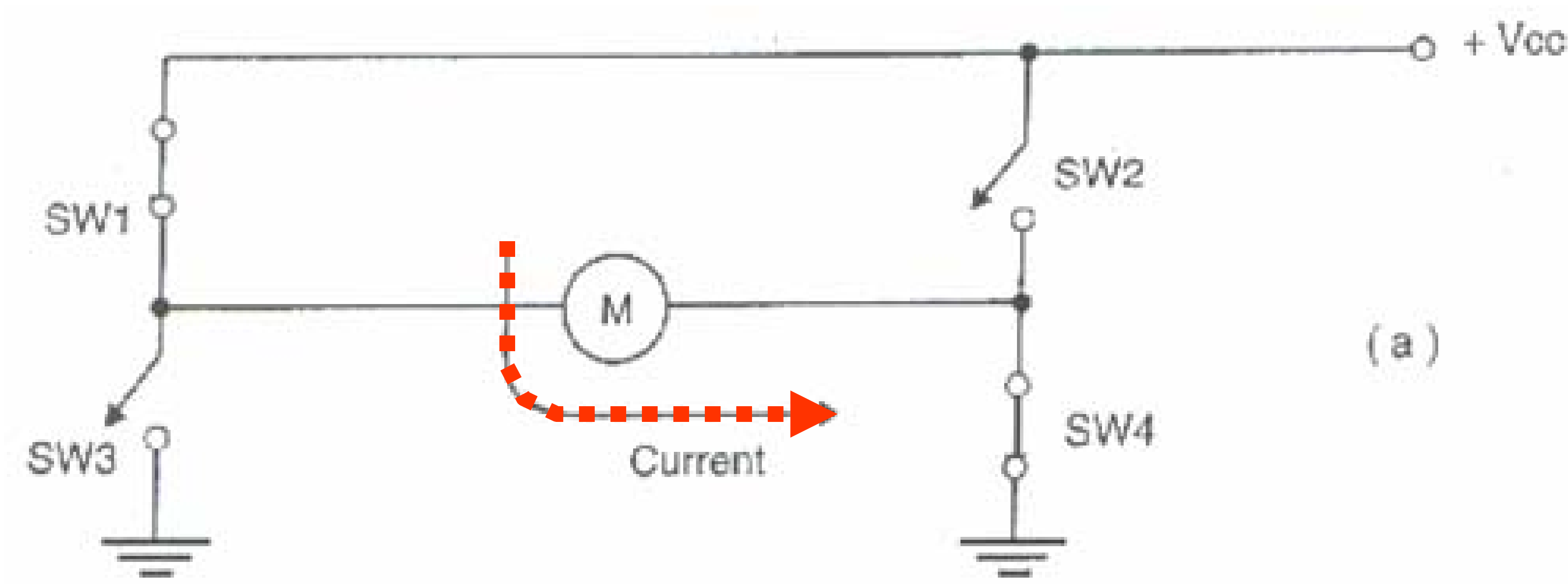
NPN BJT

H-Bridge 1



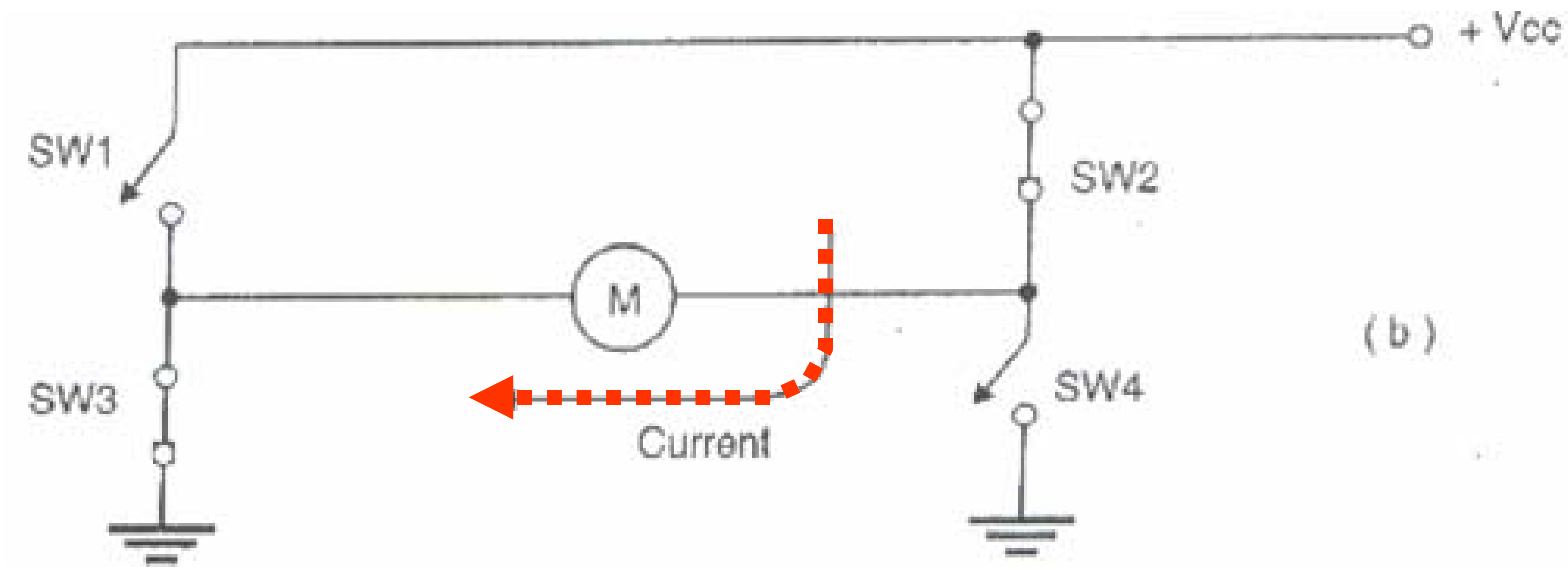
Switch

H-Bridge 2



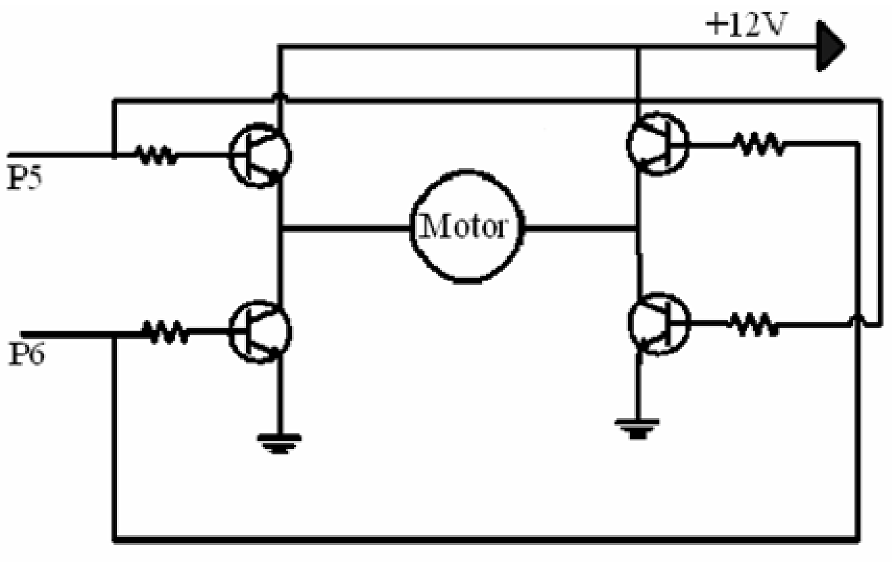
Switch

H-Bridge 3



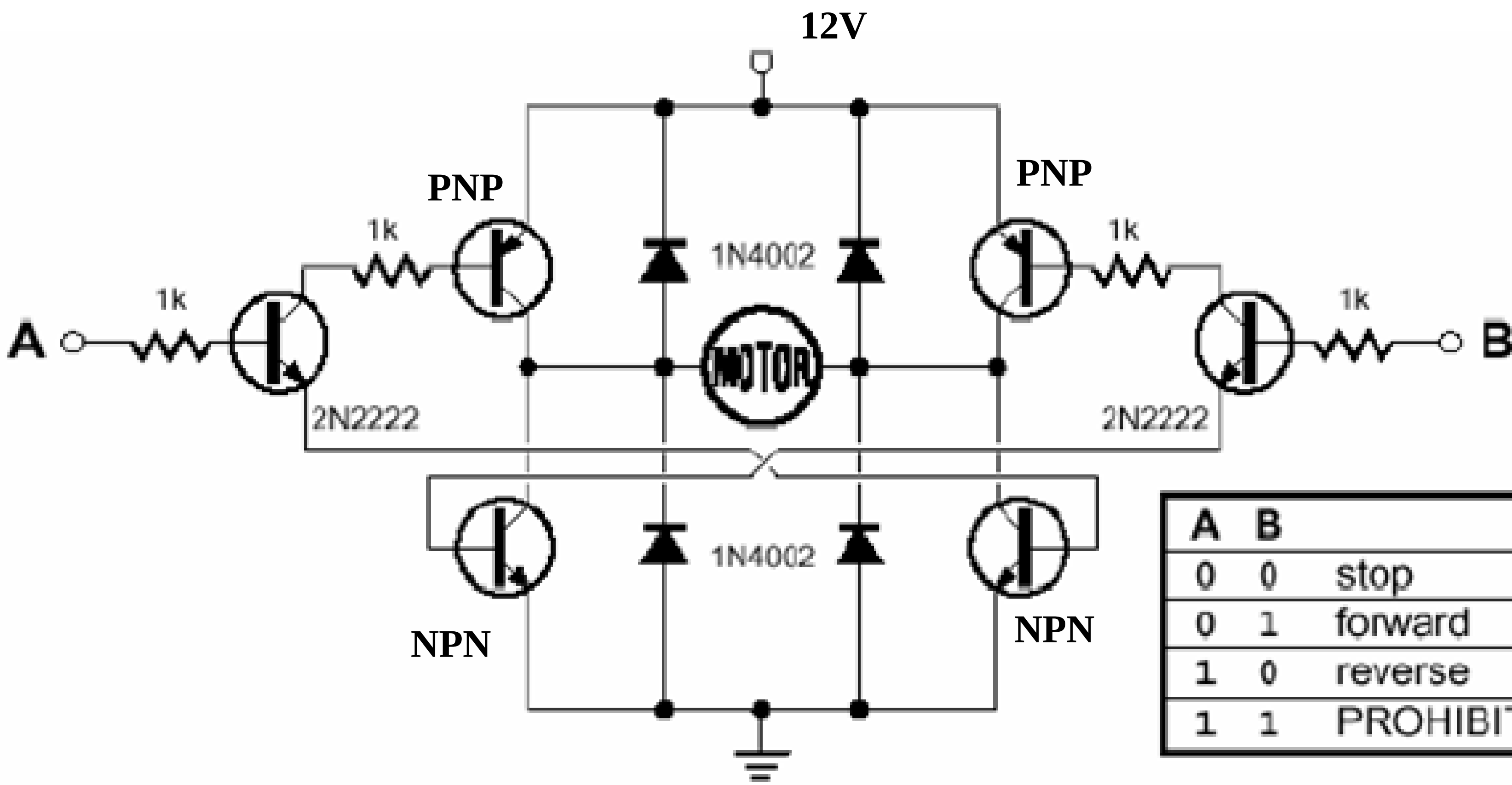
Switch

H-Bridges with NPN BJT 1



Pin5	Pin6	Motor	Notes
High	Low	forward	
Low	High	backward	
Low	Low	No motion	
High*	High*	*	Forbidden

H-Bridges with NPN BJT 2

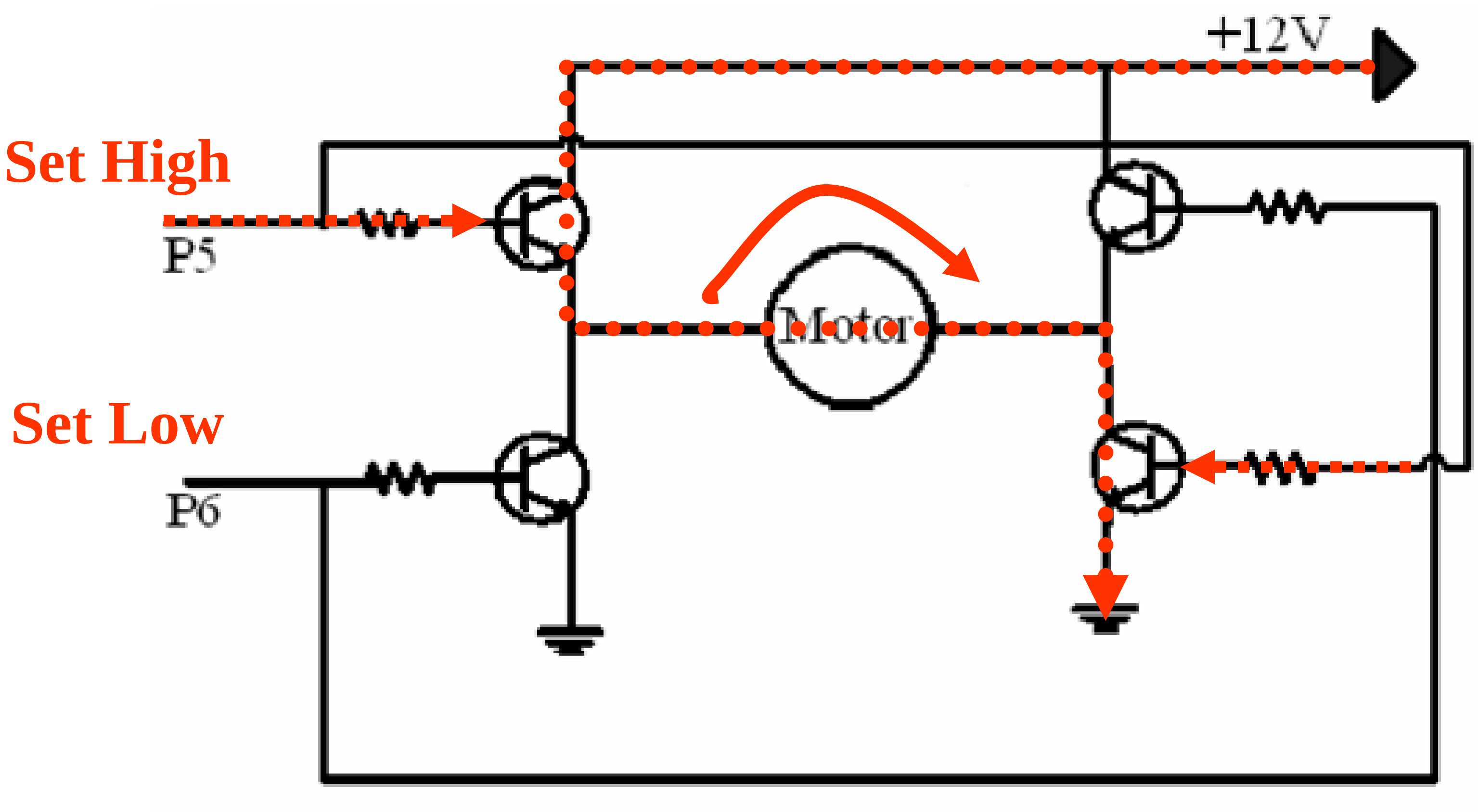


A	B	
0	0	stop
0	1	forward
1	0	reverse
1	1	PROHIBITED

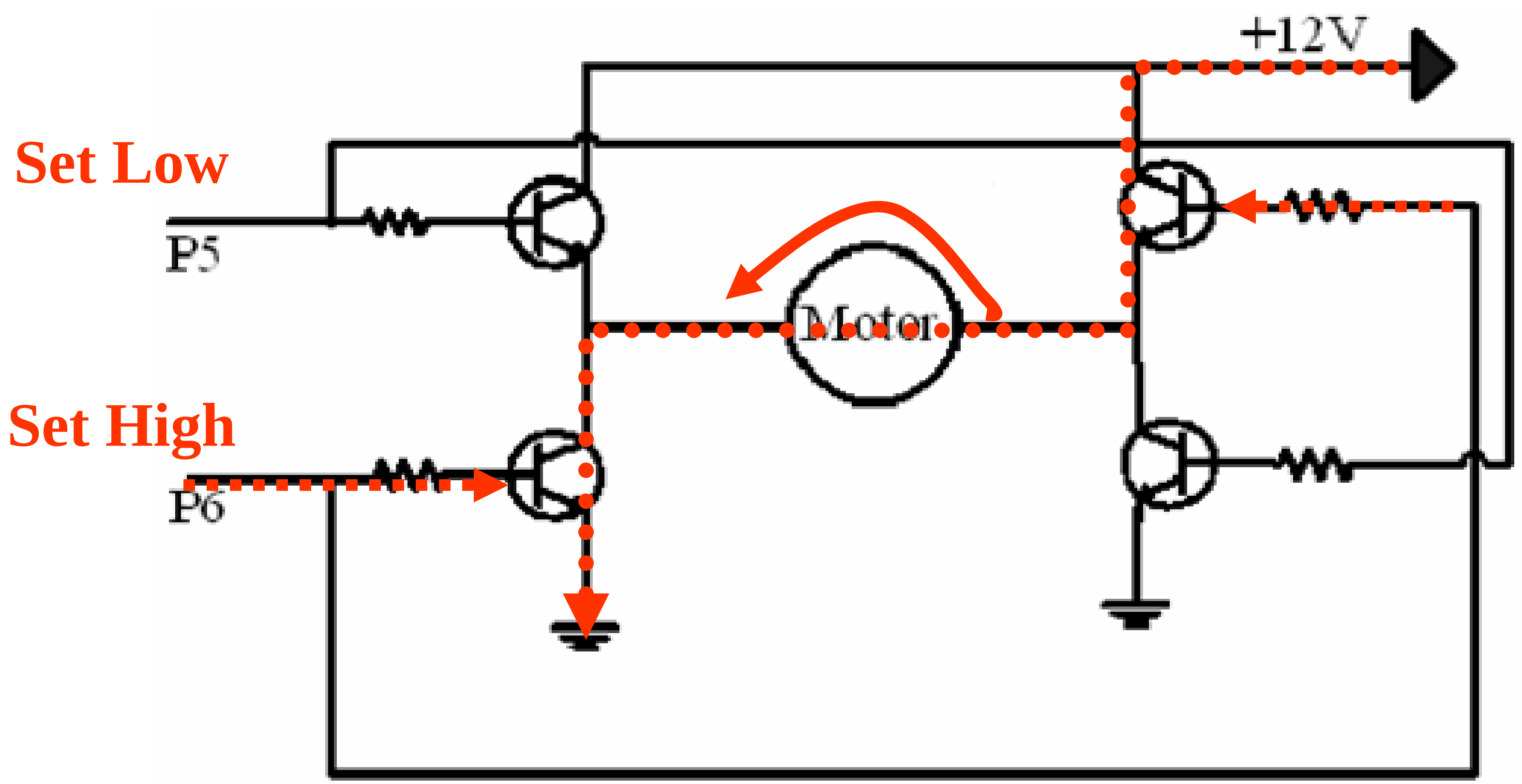
TIP42: PNP

TIP120: NPN

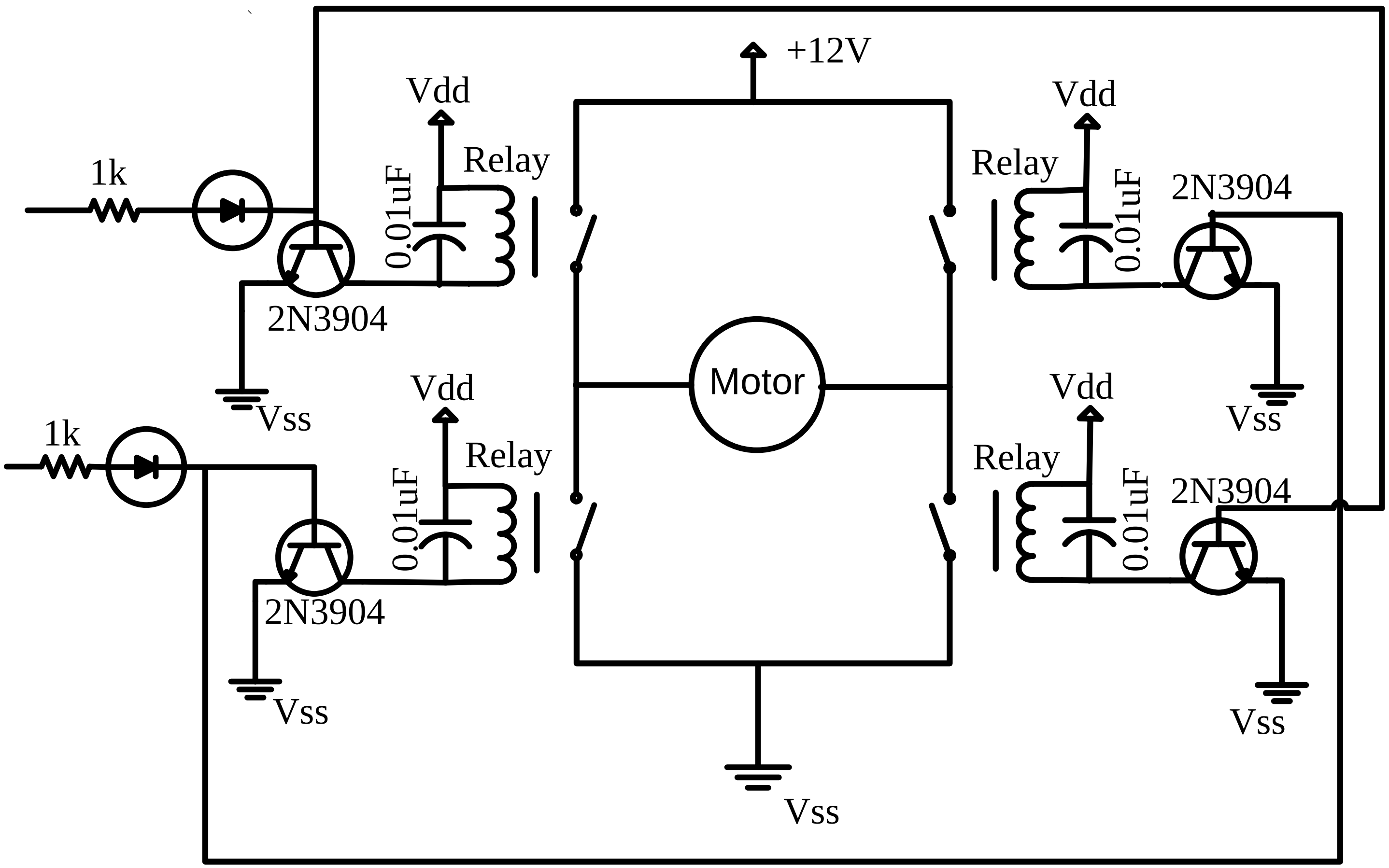
H-Bridge : How It Works



H-Bridge : How It Works



H-Bridges with Relays

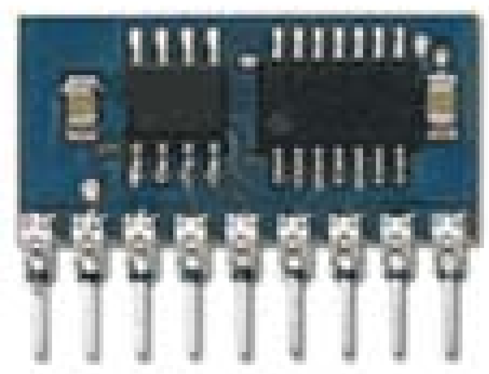


H-Bridge ICs

- LMD 18200
- LMD 18201
- LM 15200
- SN754410NE

Micro Dual Serial Motor Controller

- Using one serial output from the BASIC Stamp module, this motor controller can independently set each motor to go forward or backward at any of 127 speeds.
- To control additional motors, you can connect multiple motor controllers to the same serial line.



H-Bridge Experiments

Experiments	Chapters
What's micro controller	
Basic A and D	
Process Control	
Boe Bot Robotics	
Smart Sensors	
Others	

Lecture 17

RC filter

Linear Differential Equation

$$a_n \frac{d^n y}{dt^n} + a_{n-1} \frac{d^{n-1} y}{dt^{n-1}} + \cdots + a_0 y =$$

$$b_m \frac{d^m u}{dt^m} + b_{m-1} \frac{d^{m-1} u}{d^{m-1} t} + \cdots + b_0 u$$

First-Order System

n >= m, n = 1 $$a_1 \frac{dy}{dt} + a_0 y = u$$

Applying Laplace Transform

$$\frac{Y(s)}{U(s)} = \frac{\frac{1}{a_0}}{\tau s + 1}$$ =>

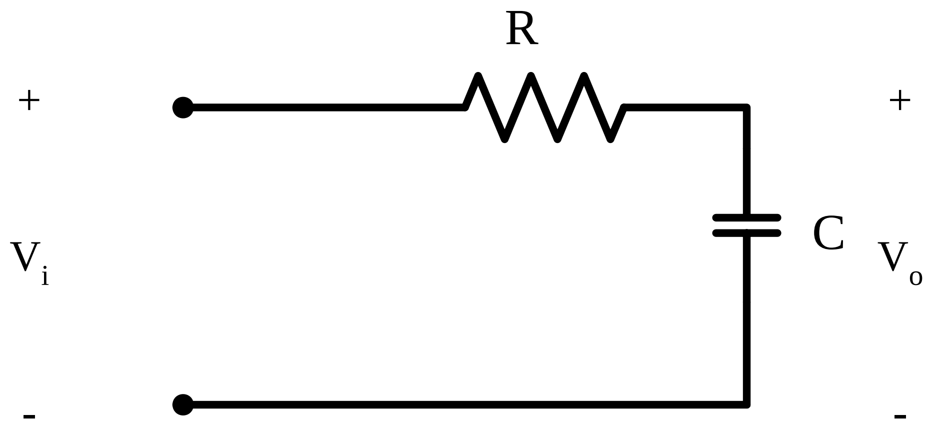
$$y(t) = (y(0) - y_\infty)e^{-\frac{t}{\tau}} + y_\infty$$

$$\tau = \frac{a_1}{a_0}$$

u(t) = A for t>=0
u(t) = 0 for t<0

$$y_\infty = \frac{A}{a_0}$$

Passive RC Low-Pass Filter



$$\frac{V_o(s)}{V_i(s)} = \frac{1}{RCs+1}$$

Bode Plot

- Bode plot is a very useful graphical approach is to analyze and design feedback loops.
- It consists of plotting two curves, the **log of gain**, and **phase**, as functions of the **log of frequency**.

$$G(s) = \frac{V_o(s)}{V_i(s)}$$

$$s = j\omega$$

$$G(j\omega) = \frac{V_o(j\omega)}{V_i(j\omega)}$$

$$G(j\omega) = |G(j\omega)|\, e^{-j\varphi(\omega)}$$

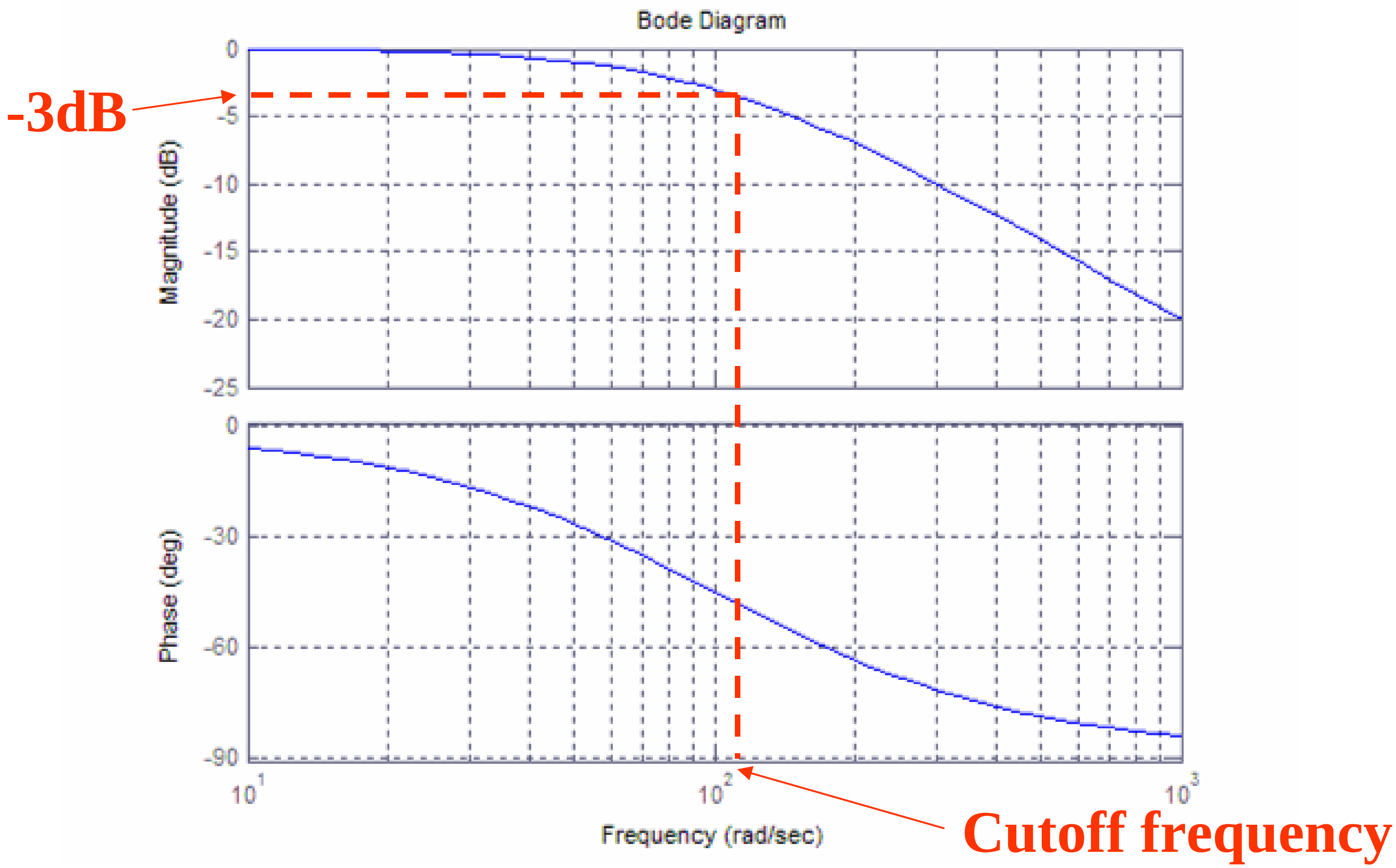
$$L(j\omega) = 20\log\left(\frac{V_o}{V_i}\right)\mathrm{dB}$$

$$\varphi(j\omega)$$

$L(j\omega)$ is log of gain, unit is dB

$\phi(j\omega)$ is phase

Bode Plot of Low-Pass Filter



- Cut off frequency is the frequency that the power of the output signal is attenuated to half of its input value

$$\frac{Ao}{Ai} = \sqrt{\frac{Po}{Pi}} = \sqrt{\frac{1}{2}} \approx 0.707$$

$$dB = 20\log_{10}\sqrt{\frac{1}{2}} = -3dB$$

$Example:$

$$G(s) = \frac{V_o(s)}{V_i(s)}$$

$$G(j\omega) = \frac{1}{RCj\omega + 1}$$

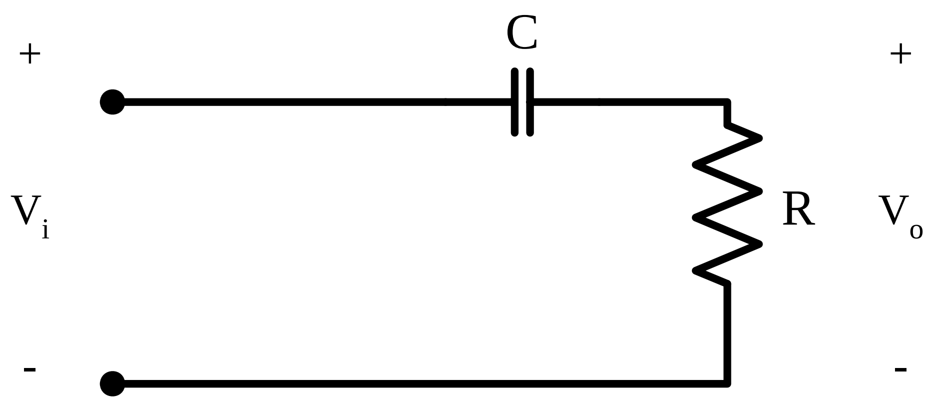
$$|G(j\omega)| = \frac{1}{\sqrt{(RC\omega_c)^2 + 1}} = \sqrt{\frac{1}{2}}$$

$$\frac{P_o}{P_i} = |G(j\omega)|^2 = \frac{1}{2} = \frac{1}{(RC\omega_c)^2 + 1}$$

$$=> 2 = (RC\omega_c)^2 + 1$$

$$\omega_c = \frac{1}{RC}$$

Passive RC High-Pass Filter



$$\frac{V_o(s)}{V_i(s)} = \frac{RCs}{RCs+1}$$

Bode Plot of High-Pass Filter