Electronics for IoT

H-Bridge

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DC Motor Speed (RPM) Control

• Objective: control
  – Direction of Rotation
  – Speed / Torque

• Forward:
  – Vary voltage to set speed
  – E.g. 6V → full speed, 3V → half speed

• Reverse:
  – Flip terminals: e.g. -6V

• Brake: Short terminals

• Never: open terminals
  – Why?

DC motor:
2 electrical terminals to apply power
H-Bridge
On-Off Control

Normal Operation

During Dead Time

Slow Decay
Inductance

Calculate (just like inertia). E.g.

\[ L = \frac{N^2 \mu A}{l} \]
\[ \mu = \mu_t \mu_0 \]

*Where,*

- \( L \) = Inductance of coil in Henrys
- \( N \) = Number of turns in wire coil (straight wire = 1)
- \( \mu \) = Permeability of core material (absolute, not relative)
- \( \mu_t \) = Relative permeability, dimensionless (\( \mu_0 = 1 \) for air)
- \( \mu_0 = 1.26 \times 10^{-6} \) T-m/At permeability of free space
- \( A \) = Area of coil in square meters = \( \pi r^2 \)
- \( l \) = Average length of coil in meters

Finite element simulation for more complicated geometries
PWM Speed Control

“ON”

“OFF”

50% duty cycle
ON OFF

75% duty cycle
ON

25% duty cycle
OFF
DRV8833 H-Bridge

1 Features
- Dual-H-Bridge Current-Control Motor Driver
  - Can Drive Two DC Motors or One Stepper Motor
  - Low MOSFET ON-Resistance: HS + LS 360 mΩ
- Output Current (at $V_M = 5$ V, $25^\circ$C)
  - 1.5-A RMS, 2-A Peak per H-Bridge in PWP and RTY Package Options
  - 500-mA RMS, 2-A Peak per H-Bridge in PW Package Option
- Outputs can be in Parallel for
  - 3-A RMS, 4-A Peak (PWP and RTY)
  - 1-A RMS, 4-A Peak (PW)
- Wide Power Supply Voltage Range: 2.7 to 10.8 V
- PWM Winding Current Regulation and Current Limiting
- Thermally Enhanced Surface-Mount Packages

3 Description
The DRV8833 device provides a dual bridge motor driver solution for toys, printers, and other mechatronic applications.

The device has two H-bridge drivers, and can drive two DC brush motors, a bipolar stepper motor, solenoids, or other inductive loads.

The output driver block of each H-bridge consists of N-channel power MOSFETs configured as an H-bridge to drive the motor windings. Each H-bridge includes circuitry to regulate or limit the winding current.

Internal shutdown functions with a fault output pin are provided for overcurrent protection, short-circuit protection, undervoltage lockout, and overtemperature. A low-power sleep mode is also provided.

The DRV8833 is packaged in a 16-pin WQFN package with PowerPAD™ (Eco-friendly: RoHS & no Sb/Br).
Block Diagram
PWM Control

Table 2. PWM Control of Motor Speed

<table>
<thead>
<tr>
<th>xIN1</th>
<th>xIN2</th>
<th>FUNCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>PWM</td>
<td>0</td>
<td>Forward PWM, fast decay</td>
</tr>
<tr>
<td>1</td>
<td>PWM</td>
<td>Forward PWM, slow decay</td>
</tr>
<tr>
<td>0</td>
<td>PWM</td>
<td>Reverse PWM, fast decay</td>
</tr>
<tr>
<td>PWM</td>
<td>1</td>
<td>Reverse PWM, slow decay</td>
</tr>
</tbody>
</table>
Breakout Board Wiring

- microcontroller outputs to GPIOs:
  - GND
  - VMM
  - BIN1
  - BIN2
  - AIN2
  - AIN1
  - nSLEEP
  - nFAULT

- Inputs from GPIOs:
  - GND
  - VIN

- Outputs to DC motors:
  - BOUT1
  - BOUT2
  - AOUT1
  - AOUT2

- DC motor power supply:
  - Motor power (2.7–10.8 V)
  - +
  - -