H-Bridge Motor Drivers

Diagram showing the H-Bridge circuit with labels A, B, C, D, and ON/OFF switches.

- A: ON
- B: OFF
- C: OFF
- D: ON

The diagram indicates that when A is ON and D is ON, the motor rotates in the Forward direction.
H-Bridge Motor Drivers

Reverse

A OFF

B ON

C ON

D OFF
H-Bridge Motor Drivers
LMD18200
H-Bridge Functional Diagram
Pinout Description

(See Connection Diagram)

Pin 1, BOOTSTRAP 1 Input: Bootstrap capacitor pin for half H-bridge number 1. The recommended capacitor (10 nF) is connected between pins 1 and 2.

Pin 2, OUTPUT 1: Half H-bridge number 1 output.

Pin 3, DIRECTION Input: See Table 1. This input controls the direction of current flow between OUTPUT 1 and OUTPUT 2 (pins 2 and 10) and, therefore, the direction of rotation of a motor load.

Pin 4, BRAKE Input: See Table 1. This input is used to brake a motor by effectively shorting its terminals. When braking is desired, this input is taken to a logic high level and it is also necessary to apply logic high to PWM input, pin 5. The drivers that short the motor are determined by the logic level at the DIRECTION input (Pin 3): with Pin 3 logic high, both current sourcing output transistors are ON; with Pin 3 logic low, both current sinking output transistors are ON. All output transistors can be turned OFF by applying a logic high to Pin 4 and a logic low to PWM input Pin 5; in this case only a small bias current (approximately −1.5 mA) exists at each output pin.

Pin 5, PWM Input: See Table 1. How this input (and DIRECTION input, Pin 3) is used is determined by the format of the PWM Signal.

Pin 6, V_S Power Supply

Pin 7, GROUND Connection: This pin is the ground return, and is internally connected to the mounting tab.

Pin 8, CURRENT SENSE Output: This pin provides the sourcing current sensing output signal, which is typically 377 μA/A.

Pin 9, THERMAL FLAG Output: This pin provides the thermal warning flag output signal. Pin 9 becomes active-low at

145°C (junction temperature). However the chip will not shut itself down until 170°C is reached at the junction.

Pin 10, OUTPUT 2: Half H-bridge number 2 output.

Pin 11, BOOTSTRAP 2 Input: Bootstrap capacitor pin for Half H-bridge number 2. The recommended capacitor (10 nF) is connected between pins 10 and 11.

<table>
<thead>
<tr>
<th>PWM</th>
<th>Dir</th>
<th>Brake</th>
<th>Active Output Drivers</th>
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<tbody>
<tr>
<td>H</td>
<td>H</td>
<td>L</td>
<td>Source 1, Sink 2</td>
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<tr>
<td>H</td>
<td>L</td>
<td>L</td>
<td>Sink 1, Source 2</td>
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<tr>
<td>L</td>
<td>X</td>
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<td>L</td>
<td>X</td>
<td>H</td>
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Application Information

TYPES OF PWM SIGNALS

The LMD18200 readily interfaces with different forms of PWM signals. Use of the part with two of the more popular forms of PWM is described in the following paragraphs.

Simple, locked anti-phase PWM consists of a single, variable duty-cycle signal in which is encoded both direction and amplitude information (see Figure 2). A 50% duty-cycle PWM signal represents zero drive, since the net value of voltage (integrated over one period) delivered to the load is zero. For the LMD18200, the PWM signal drives the direction input (pin 3) and the PWM input (pin 5) is tied to logic high.
PMDC Motors

- Stator
- Rotor
- Commutator
- Brushes
- Field Magnets
- Torque

(i), (ii), (iii), (iv), (v)
PMDC Motors

- **Simple Model**
  \[ V_{\text{in}} = L \frac{dI}{dt} + RI + K_E \omega \]
  \[ \tau = K_T I \]

- **More Complete Model**
  Coulomb Friction
  Viscous Friction
PMDC Motors

• More Complete Model

\[ V_{in} = L \frac{dl}{dt} + RI + K_E \omega \]

\[ \tau = K_T l = J\alpha - D_v \omega + D_c \text{sign}(\omega) \]
# PMDC Motors

## DC Motor Specifications

<table>
<thead>
<tr>
<th>Motor Data</th>
<th>Winding number</th>
<th>930</th>
<th>933</th>
<th>934</th>
<th>948</th>
<th>936</th>
<th>944</th>
<th>937</th>
<th>938</th>
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<td>2. Nominal voltage</td>
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<td>3. No load speed</td>
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<td>9460</td>
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<td>4. Stall torque</td>
<td>mNm</td>
<td>20.9</td>
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<td>rpm/mNm</td>
<td>260</td>
<td>225</td>
<td>213</td>
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<td>6. No load current</td>
<td>mA</td>
<td>114</td>
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<td>7. Starting current</td>
<td>mA</td>
<td>3960</td>
<td>5910</td>
<td>5160</td>
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<td>3090</td>
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<td>8. Terminal resistance</td>
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<td>10. Max. continuous current</td>
<td>mA</td>
<td>1500</td>
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<td>1440</td>
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<td>11. Max. continuous torque</td>
<td>mNm</td>
<td>7.92</td>
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<td>12. Max. power output at nominal voltage</td>
<td>mW</td>
<td>2460</td>
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<td>10800</td>
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<td>13. Max. efficiency</td>
<td>%</td>
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<td>16. Mechanical time constant</td>
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<td>17. Rotor inertia</td>
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<td>9.23</td>
<td>9.07</td>
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</table>
Brushless DC Motors

- Rotor with permanent magnets
- Stator with windings
- Essentially a DC motor turned inside out
- Control electronics take the place of brushes and commutators
Brushless DC Motors

CW Rotation Elec. Deg.

0 180 360

Hall 1
Hall 2
Hall 3

ΦA Off
Lo

Hi

ΦB Off
Lo

Hi

ΦC Off
Lo

Decoder Circuit

H1
H2
H3

Servo Magnetics Inc.
4-Pole Brushless DC Motor
Commutation, drive, and winding timings
Drawing & Animation: Brad Pera
Stepper Motors

- Essentially a brushless DC motor with many more stator and rotor poles.
Stepper Motors

• Full Step Motor

Phase ‘b’ energized
Actuators (1)

Stepper Motors

• Half Step Motor

Phase ‘a’ energized
Stepper Motors

- Half Step Motor

Phases ‘a’ and ‘b’ energized