Introduction to H-Bridge
How does a motor turn?

- If you want to change the direction of the rotation, change the direction of current flow.
How much current does a motor need?

- Your nano board works @ 5 V, 0.5 Ams AT MOST
- Depending on the application, motors need huge amount of voltage and current
How much current does a motor need?

- Can I connect my Nano board to 25K Volts?
  - Yes you can
    - Please inform me before doing it, I will run away from you as far as possible

- You should use electric switch
  - Relay
  - Transistor/h-Bridge
The small current flowing from coil creates electro-magnetic force which attracts the pivoted contact and circuit is closed on the large current side

- Provides isolation
- Slow reaction due to mechanical motion
- Drive signal A & B from your Nano board
  - Transistor is an electronic switch
  - What happens if A = 1, B = 1 and V = 25 K?
H-Bridge

- A & B must be driven by square wave pulses as shown above
  - Have you seen such square wave before?
H-Bridge Inverter Basics – Creating AC from DC

Single-phase H-bridge (voltage source) inverter topology:

\[ V_{load} = V_A - V_B = V_{AB} \]

**Switching rules**
- Either A+ or A− is closed, but **never** at the same time *
- Either B+ or B− is closed, but never at the same time *
- *Same time closing would cause a short circuit from Vdc to ground (shoot-through)*
- *To avoid shoot-through when using real switches (i.e. there are turn-on and turn-off delays) a dead-time or blanking time is implemented*

**Corresponding values of Va and Vb**
- A+ closed, \( V_a = V_{dc} \)
- A− closed, \( V_a = 0 \)
- B+ closed, \( V_b = V_{dc} \)
- B− closed, \( V_b = 0 \)
Corresponding values of Vab
• A+ closed and B– closed, Vab = Vdc
• A+ closed and B+ closed, Vab = 0
• B+ closed and A– closed, Vab = −Vdc
• B– closed and A– closed, Vab = 0

The free wheeling diodes permit current to flow even if all switches are open
• These diodes also permit lagging currents to flow in inductive loads

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Corresponding values of $V_{ab}$
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- $A^+ \text{ closed and } B^+ \text{ closed, } V_{ab} = 0$
- $B^+ \text{ closed and } A^- \text{ closed, } V_{ab} = -V_{dc}$
- $B^- \text{ closed and } A^- \text{ closed, } V_{ab} = 0$

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H-Bridge Inverter

• Square wave modulation:
Basic Square Wave Operation
(sometimes used for 50 Hz or 60Hz applications)

- A+ closed and B– closed, V_{ab} = V_{dc}
- A+ closed and B+ closed, V_{ab} = 0
- B+ closed and A– closed, V_{ab} = -V_{dc}
- B– closed and A– closed, V_{ab} = 0

The V_{ab} = 0 time is not required but can be used to reduce the rms value of V_{load}
Many Loads Have Lagging Current – Consider an Inductor

There must be a provision for voltage and current to have opposite signs with respect to each other.

\[ V_{load} \]
\[ V_{dc} \]
\[ -V_{dc} \]
\[ I_{load} \]
\[ I \]
\[ -I \]
Component: H-bridge Circuit

- L298 chip & Circuit
Driving Mode
Goals

- Forward
- Backward
- Rotate clockwise
- Rotate anticlockwise
- Free running (Option)
Drive Forward

- All wheels
  - Same speed
  - Rotate forward
Drive Backward

- All wheels
  - Same speed
  - Rotate backward
Rotate Clockwise

- The left wheel
  - Same speed
  - Rotate clockwise

- The right wheels
  - Same speed
  - Rotate anticlockwise
Rotate Anticlockwise

- Two left wheels
  - Same speed
  - Rotate anticlockwise

- Tow right wheels
  - Same speed
  - Rotate clockwise
Let’s dance

- Control application in different modes
  - Use timer to switch modes
Questions