

ELFDRV1 - Stepper Driver

Rev 1.0

electroFUN LTD

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BRIEF

The ELFDRV1 stepper motor driver carrier is an easy-to-use performant bipolar micro-stepping motor driver. The driver features adjustable current limiting, over current protection, and 4 different configurable micro-step resolutions. It operates from 8 V – 35 V and can deliver up to 2.5 A per coil. Fitted with external diodes to improve the over all thermal dissipation of the driver.

Description

The ELFDRV1 is a compact carrier board or breakout board for TI's DRV8818 Micro-stepping Driver with Indexer and over-current protection for driving stepper motors. This stepper driver lets you control one bipolar stepper motor up to 2.5 A per winding. Please refer to the heat dissipation section of this manual for optimum performance.

Features

FEATURES

1. Just two control interface pins for *step* and *direction*.
2. One interface pin to *enable* the driver.
3. Four different step resolutions jumper configurable: full-step, 1/2, 1/4, 1/8.
4. Adjustable current control lets you set the maximum current output with a potentiometer, allowing you to use a wide range of supply voltages well above your stepper motor's rated voltage. This will protect your motor and will enable you to achieve higher step rates.
5. Selectable decay modes using built in jumpers: *slow decay*, *fast decay* or *mixed decay*. Mixed decay provides a more intelligent chopping control by selecting the correct current decay mode automatically (board default).
6. Board has been designed for vertical mounting for optimum cooling under high current needs. In addition it occupies less space on your final project.

The ELFDRV1 ships with all SMD components soldered on board, tested and with a set of header pins for you to solder.

We also have an Arduino (UNO Rev 3 and Leonardo) or vinciDuino daughter board (shield) that can host up to 3 ELFDRV1s, making it an ideal and compact solution for driving a CNC machine. Please refer to the ELFSHL1.

Specifications

Dimensions

Size: 43mm x 33 mm

Weight: 6g

General specifications

Motor driver: DRV8818

Logic operating voltage range: 3 V - 5.5V

Motor driver operating voltage range: 8 V - 35 V

Continuous output current per phase: up to 2.5 A

Min step pulse duration: 1us

PCB: FR4, 35um copper

white solder resist

1.6 mm

USER GUIDE

CONFIGURATION AND USAGE

1. Using the Driver
2. Power pin connection and wiring
3. Driver Configuration
4. Driver Control
5. Thermal Considerations

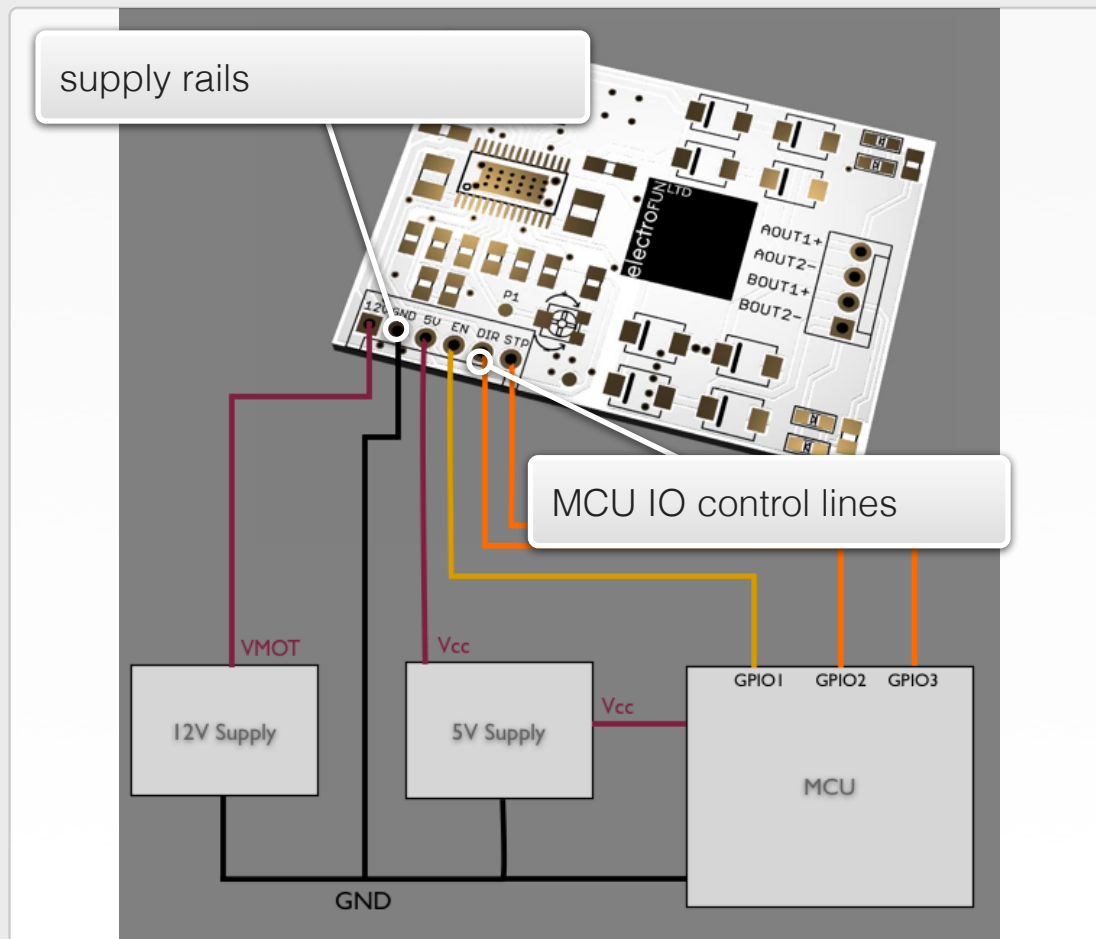
Using the driver

The driver has been designed for minimum configuration and external control from an MCU, just a simple step command (HIGH-LOW pulse) on the STP pin and a direction pin, DIR, HIGH or LOW to turn the motor clockwise or anti-clockwise. A simple *EN pin (active low) will enable or disable the ELFDRV1 output drivers.

The driver comes pre-configured to work in mixed decay mode, giving a more flexible configuration for its current recirculation. The driver is configured in 1/8 step mode and can easily be reconfigured using 2 solder jumpers.

Minimal wiring diagram for connecting a microcontroller to the ELFDRV1 stepper motor driver carrier.

ELFDRV1 stepper driver supply rails



supply rails:

VMOT: 8 V to 35 V - marked as 12 V on the PCB.

Vcc: 3 V to 5.5 V - marked as 5 V on the PCB.

GND: common ground between supply rails.

MCU IO control lines:

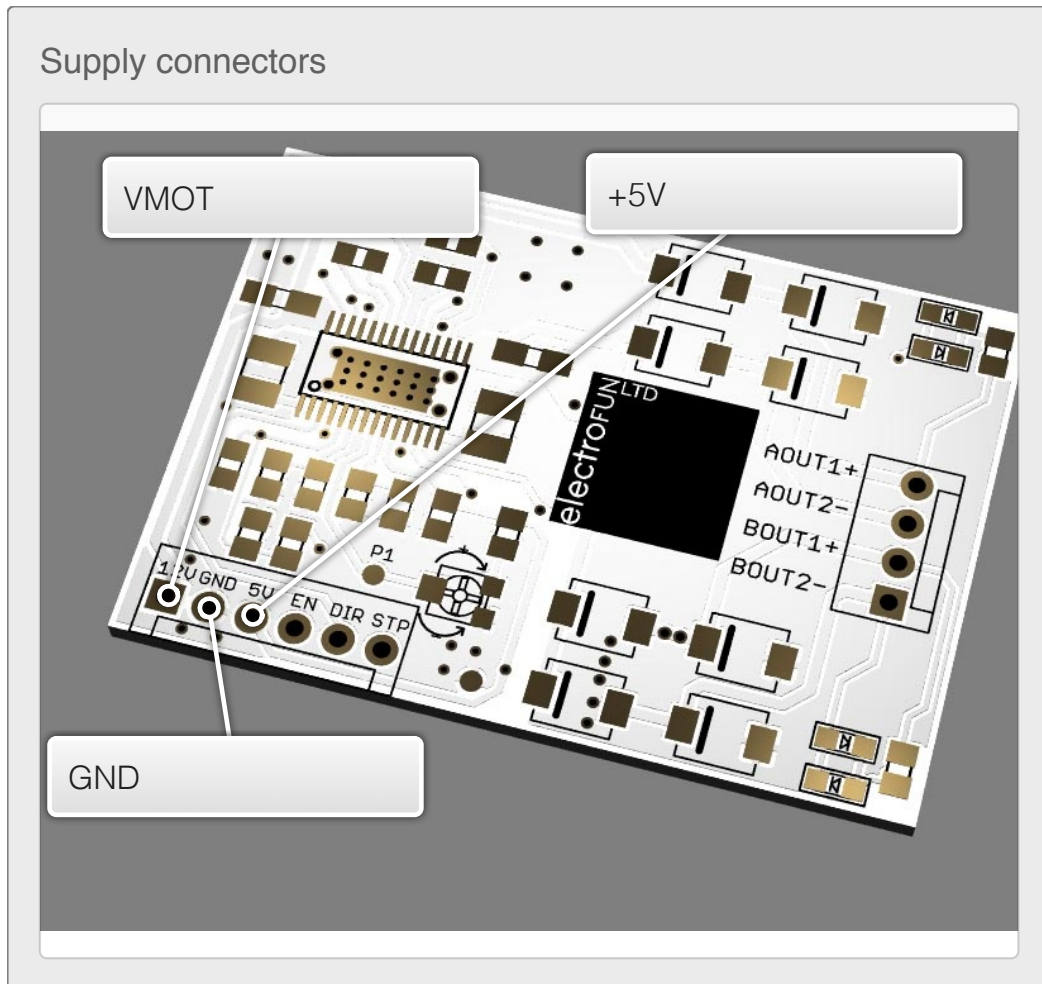
*EN** = active low

DIR = HIGH or LOW - CW, ACW

STP = HIGH + LOW pulse

Power connections

The driver requires a logic supply voltage (3 V – 5.5 V) to be connected across the Vcc and GND pins and a motor supply voltage of (8 V – 35 V) to be connected across VMOT and GND. VMOT supply should have appropriate decoupling capacitors close to the board (if using the CNC stepper mother board - *ELFSHL1* shield - VMOT bypass capacitor is already fitted).



VMOT: Motor driver voltage - 8 V to 35 V pin

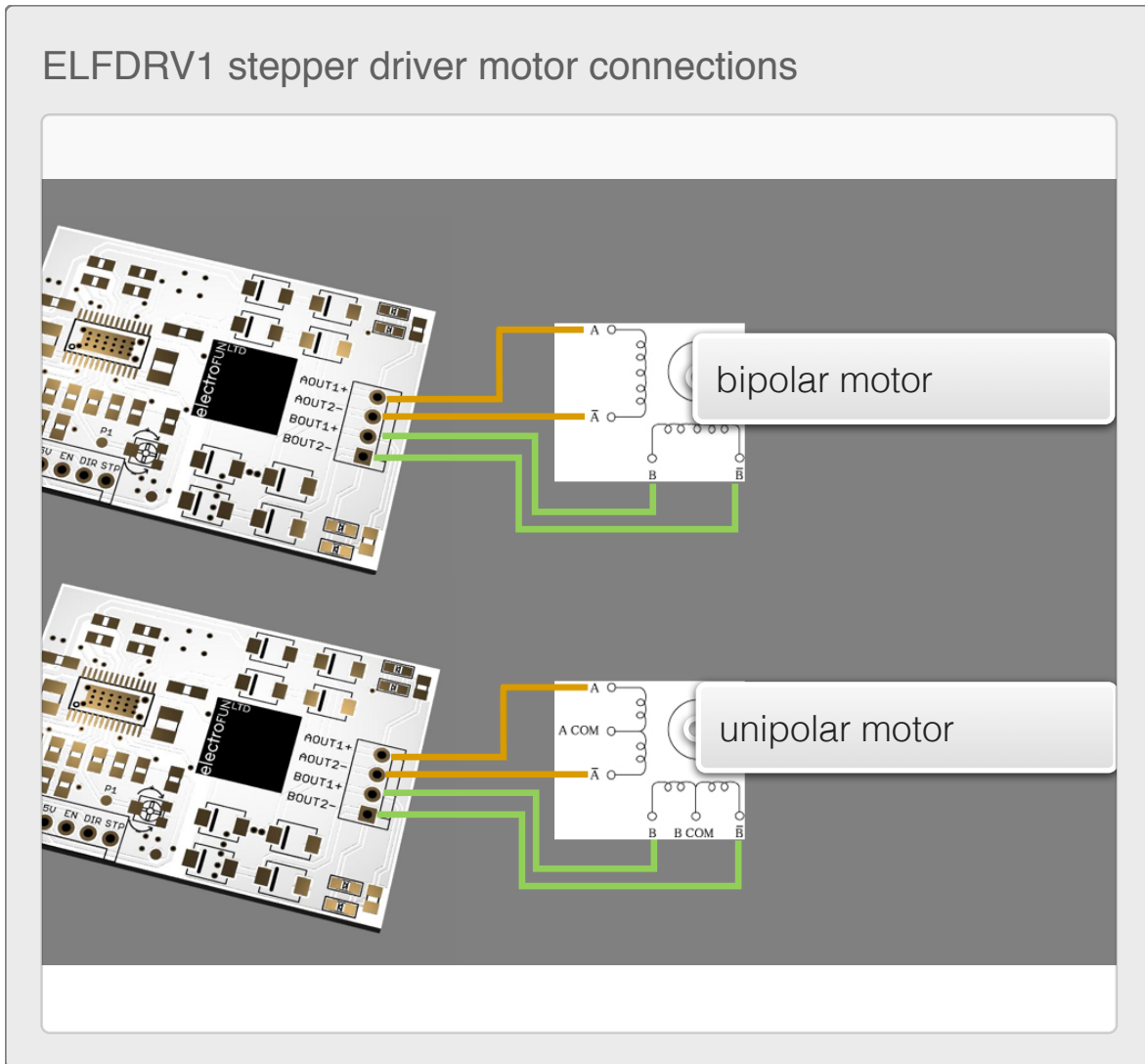
GND: ground reference pin

+5V: logic supply for the driver -

Warning: This driver board uses low-ESR ceramic capacitors, which makes it susceptible to LC voltage spikes. At times, these spikes can well exceed the 35 V maximum voltage rating for the DRV8818 and can permanently damage the driver (even when the motor supply voltage is as low as 12 V). One way to protect the driver from such LC voltage spikes is to place a large ($\geq 47\mu\text{F}$) electrolytic cap on the +12V power rail.

Motor Connections

ELFDRV1 stepper driver motor connections



bipolar motor are connected directly to the driver. Ensure that phases coincide.

unipolar motors with 6 and 8 wires can be connected to the driver as if they were bipolar motors. The center tap *A COM* can be connected instead of *A'* to reduce the inductance, you will be able to get higher step orders while sacrificing torque.

Warning: Connecting or disconnecting a stepper motor while the driver is powered can destroy the driver (in general, rewiring anything while it is powered is asking for trouble).

Driver Configuration

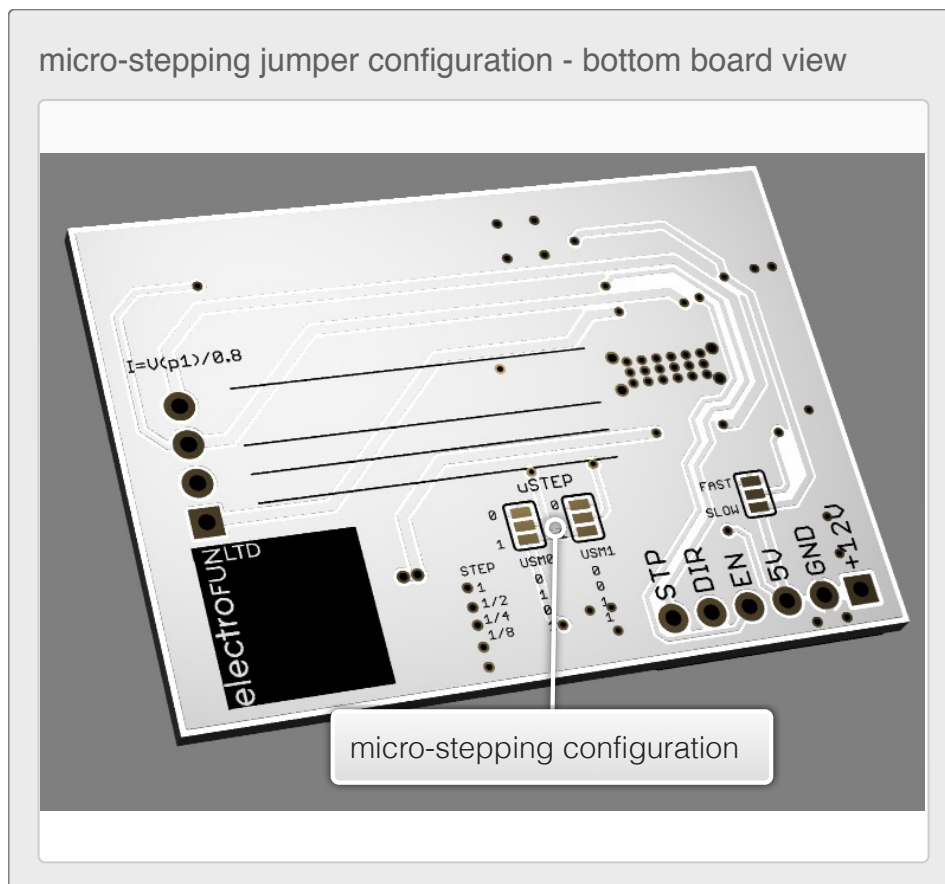
micro-stepping

Most stepper motors have a step size of 1.8° or 200 steps per revolution. This is the step resolution that would be achieved when the driver is configured in *full step* mode.

This micro-stepping driver allows for higher step resolutions. This is managed internally by the DRV8818 by energizing the coils with intermediate current levels.

Step resolution for 200 steps per revolution motor:

- Full step: 200 steps per revolution / 1.8°
- 1/2: 400 steps per revolution / 0.9°
- 1/4: 800 steps per revolution / 0.45°
- 1/8: 1600 steps per revolution / 0.225°



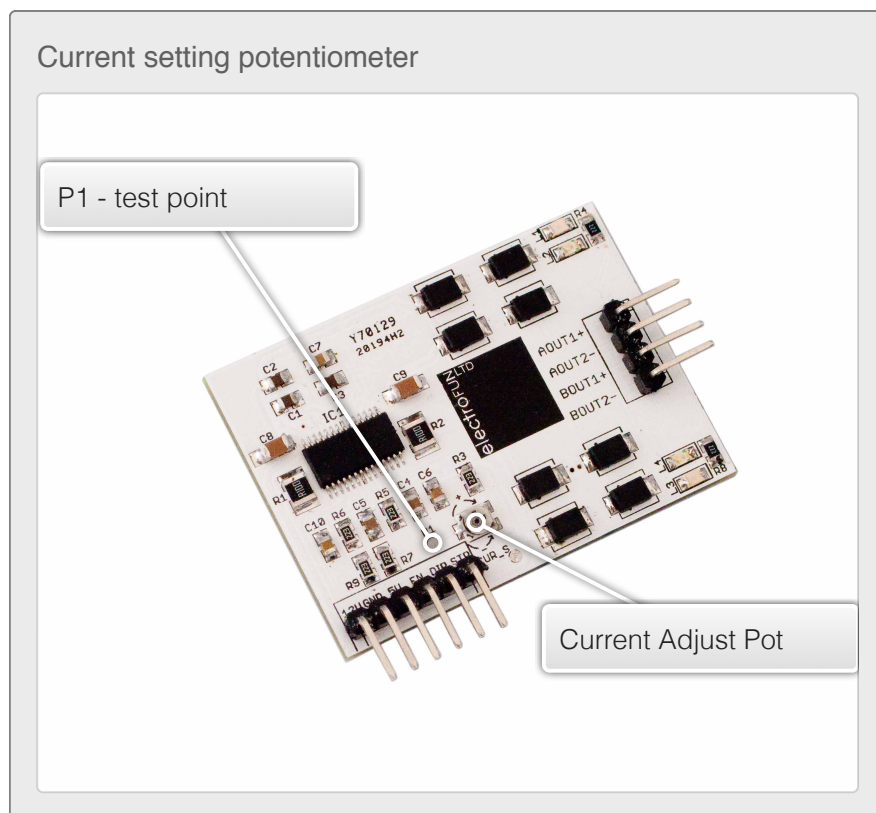
The step size can be configured using the built-in jumpers, which can be found at the back of the board. The board is configured in 1/8 of a step, with jumpers on uSTEP configured to USM0 = 1 and USM1 = 1, by default.

Current limiting

To achieve higher step rates, the motor supply should be much higher than would be permissible without active current limiting (current chopping). For example, most stepper motor specify what their maximum current ratings and coil resistance is as opposed to their rated voltage. This is because they specify the current rating at which the motor coils are rated

If we consider a typical 2A stepper motor with a 2.5Ω coil resistance, it would indicate a maximum motor supply of 5 V. However, if we want to achieve higher step rates, we would need to energize the coils quicker by simply raising the voltage to 12 V (for example). However, we should be actively limiting the current to be under 2 A to prevent damage to the motor's coils.

The ELFDVR1 is based on TI's DRV8818 which supports such active current limiting. It is configured using the onboard trimmer potentiometer.



The easiest way to configure the output current per phase, is to power the board with a 5V supply (or the voltage you are going to use on your project) using the +5V and GND pins. Measure the voltage on test point P1 (please refer to image) and adjust the potentiometer. The coil current is calculated as follow:

$$I(C) = V(P1) / 0.8$$

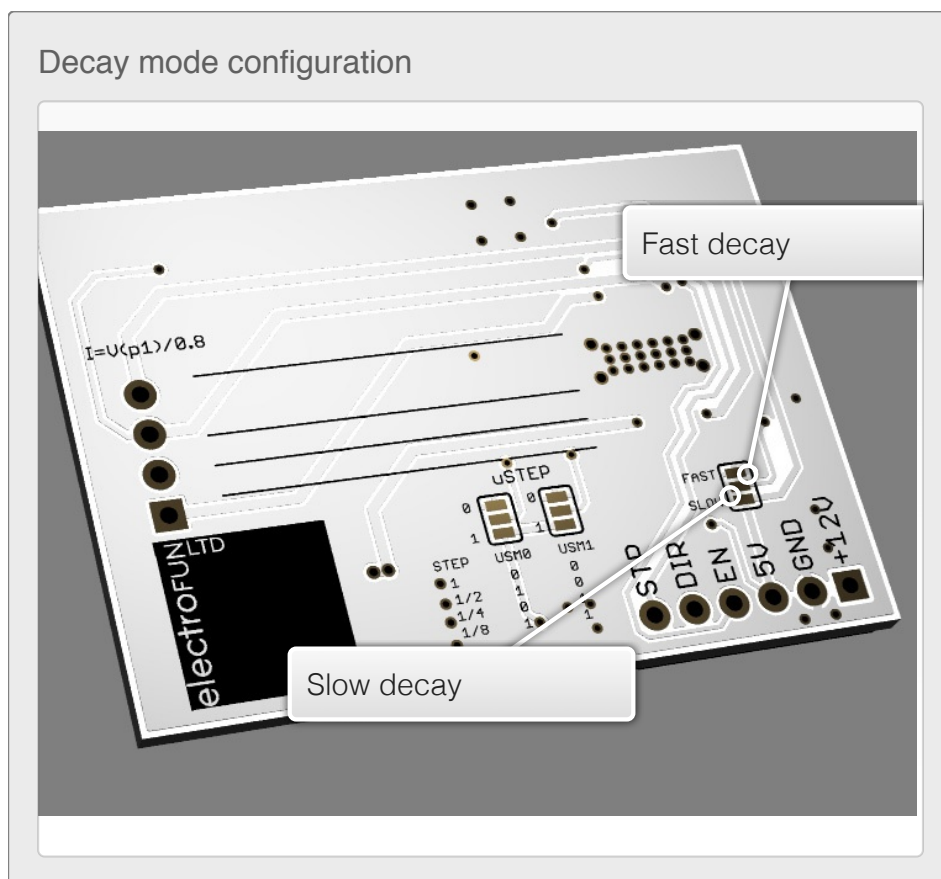
For example, to achieve a 1A coil current, you should adjust the potentiometer till you read 0.8 V on test point P1. By default, the board is configured to deliver 1 A per phase (trimmed using +5V on Vcc).

Warning: do not exceed to 2.5 A maximum current rating of the board. It will get very hot and continuous usage beyond the 2.5A rating will cause permanent damage to the driver. This is the same as saying, never exceed $V(P1) = 2\text{ V}$ when the board is in use in your project.

Decay mode configuration

The decay mode can be configured by using a simple solder jumper. By default (solder jumper completely open) it is configured in mixed decay mode.

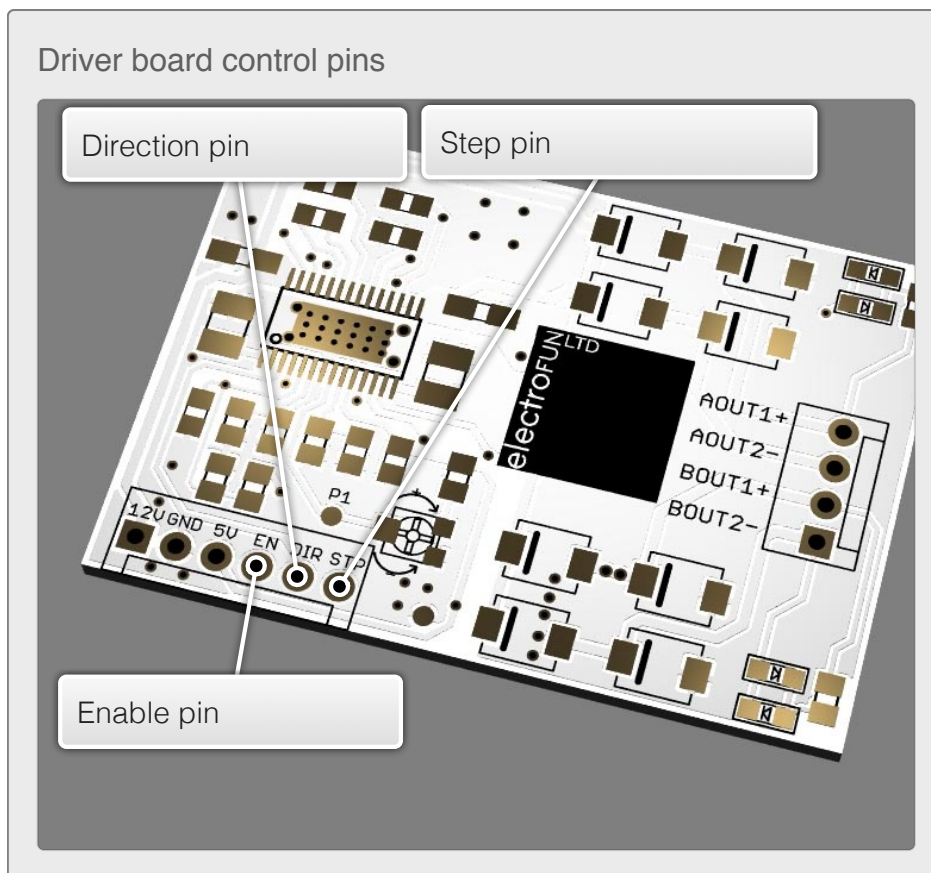
In mixed decay mode, the driver automatically selects the best coil discharge mechanism at a particular instant in time (slow or fast decay). This is what we call automatic discharge selection. If you are doing micro-stepping mixed decay mode is the only way to go.



If you don't know what decay mode is, please leave the default configuration.

Driver Control

Each pulse to the STP input corresponds to one micro-step of the stepper motor in the direction selected by the DIR pin. These pins need to be actively driven and should not be left floating. Should you wish to only have the motor turning in only one direction, you can tie the DIR pin to Vcc or GND.



You will also need to control the *EN pin of the board to activate the output drivers of the DRV8818.

The pulse (high-low cycle) on the STP pin should have a duration of at least 1us.

Thermal Considerations

The DRV8818 ASIC, and hence the ELFDVR1, driver has a maximum current rating of 2.5 A per phase. The actual current it can deliver depends very much on how well you cool the DRV8818.

Care has been taken when designing the circuit board to allow regular operation up to 1.5 A per phase. However, the actual current you can deliver the motor depends on how well you can keep the DRV8811 cool. We have achieved 2 A sustained operation with a heat sink and 2.5 A with a heat sink and forced air cooling.

HARDWARE

HARDWARE FILES

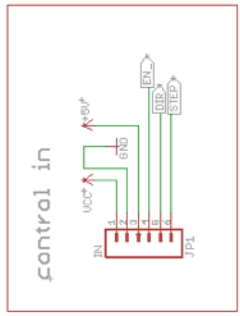
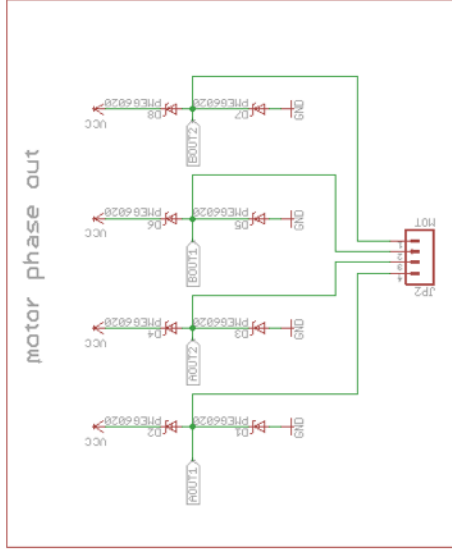
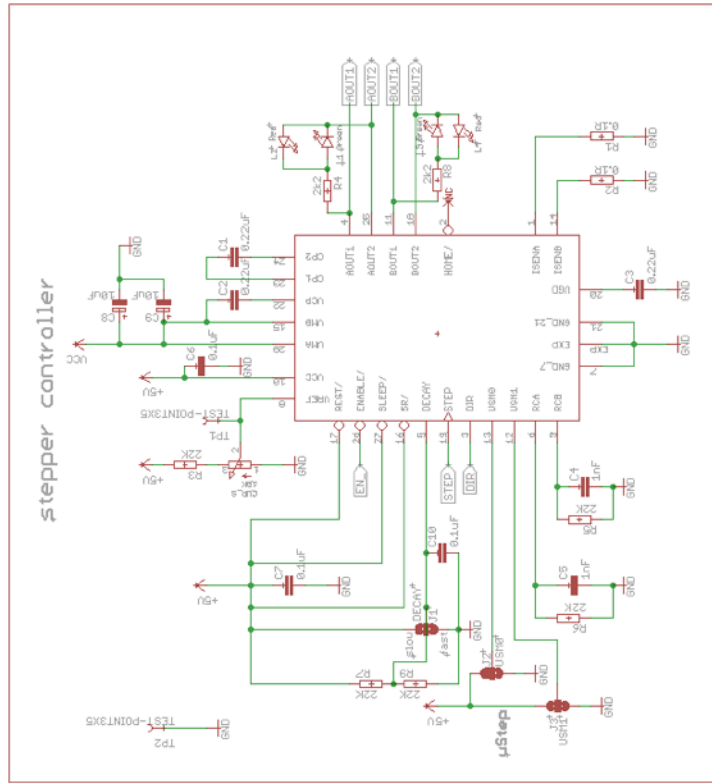
1. Schematic
2. Board layout
3. Board dimensions

Main hardware related section with the board schematics, board layout and components, mechanical drawings with board dimensions.

Original files can be download from www.electrofunLTD.com

Schematic

Stepper Driver - ELFDRV1

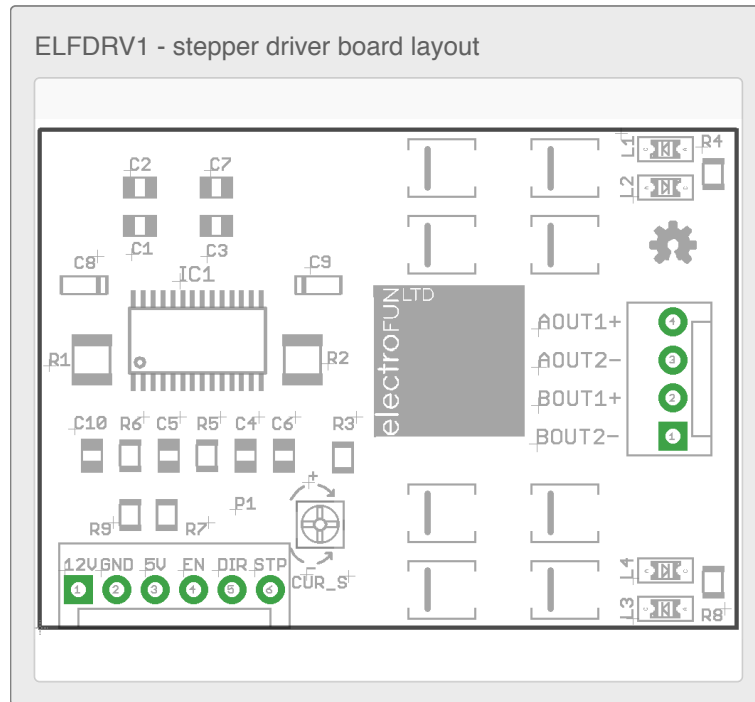


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REV: B.1
STEPPER DRIVER

Board Layout



Components

| Part | Value | Package |
|-------------|---------|-------------------|
| C1, C2, C3 | 0.22uF | C0805 |
| C4, C5 | 1nF | C0805 |
| C6, C7, C10 | 0.1uF | C0805 |
| C8, C9 | 10uF | A/3216-18R |
| CUR_S | 10K | TRIMPOT_BOURNS3MM |
| D1 - D8 | diode | SOD-128 |
| IC1 | DRV8818 | HTSSOP28PWP |
| JP1 | IN | MOLEX-1X6 |
| JP2 | MOT | MOLEX-1X4 |
| L1, L3 | Green | CHIPLED_0805 |
| L2, L4 | Red | CHIPLED_0805 |
| R1 - R2 | 0.1R | R1210 |
| R3, R5 - R9 | 22K | M0805 |
| R4 | 2k2 | M0805 |

Board Dimensions

