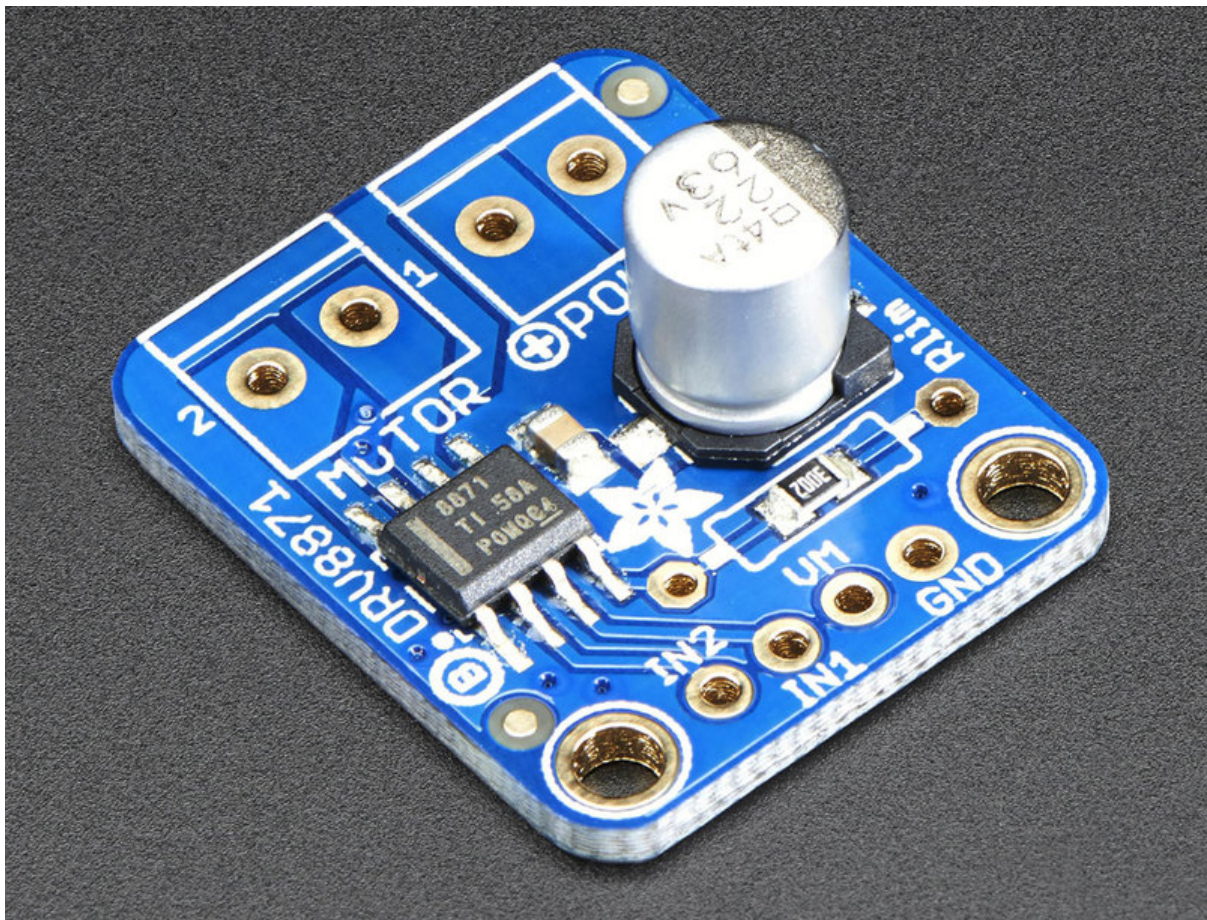




Adafruit DRV8871 Brushed DC Motor Driver Breakout

Created by lady ada



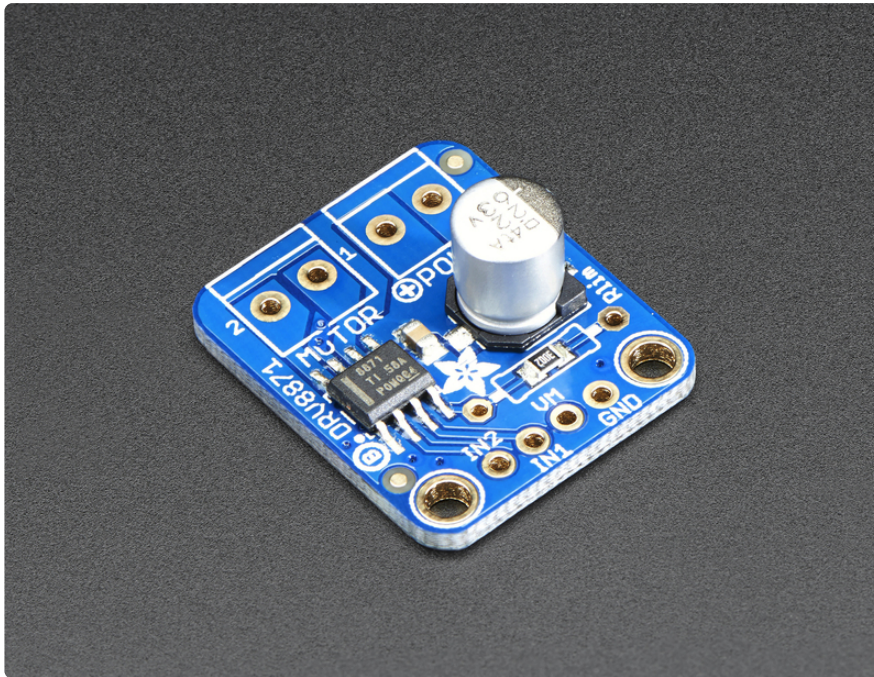
<https://learn.adafruit.com/adafruit-drv8871-brushed-dc-motor-driver-breakout>

Last updated on 2024-06-03 01:57:11 PM EDT

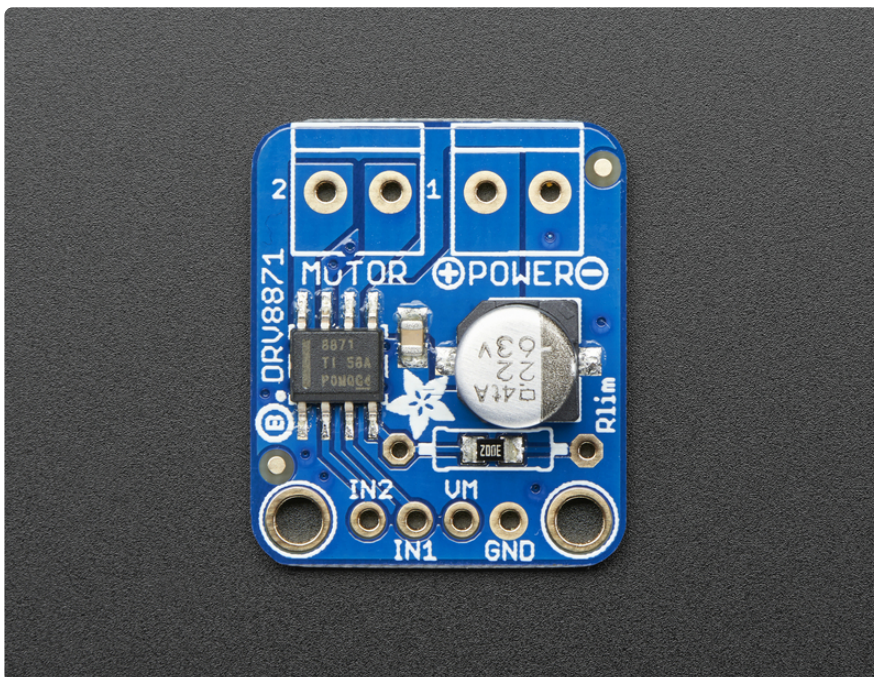
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Overview



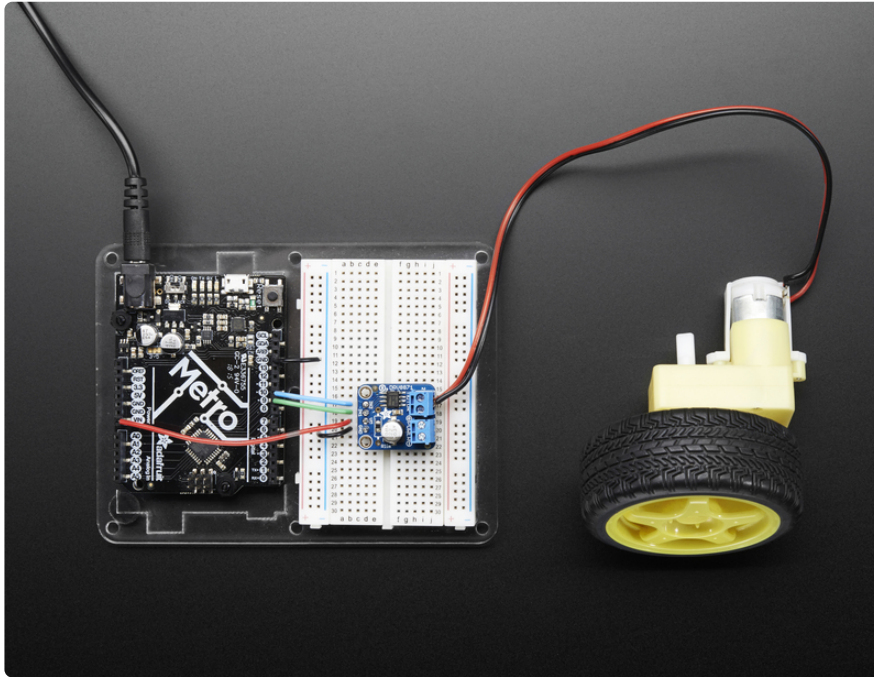
Crank up your robotics with powerful **Adafruit DRV8871** motor driver breakout board. This motor driver has a lot of great specs that make it useful for a wide variety of mechatronics. In particular, the simple resistor-set current limiting and auto-magic PWM support make it super easy to use with almost any brushed DC motor.



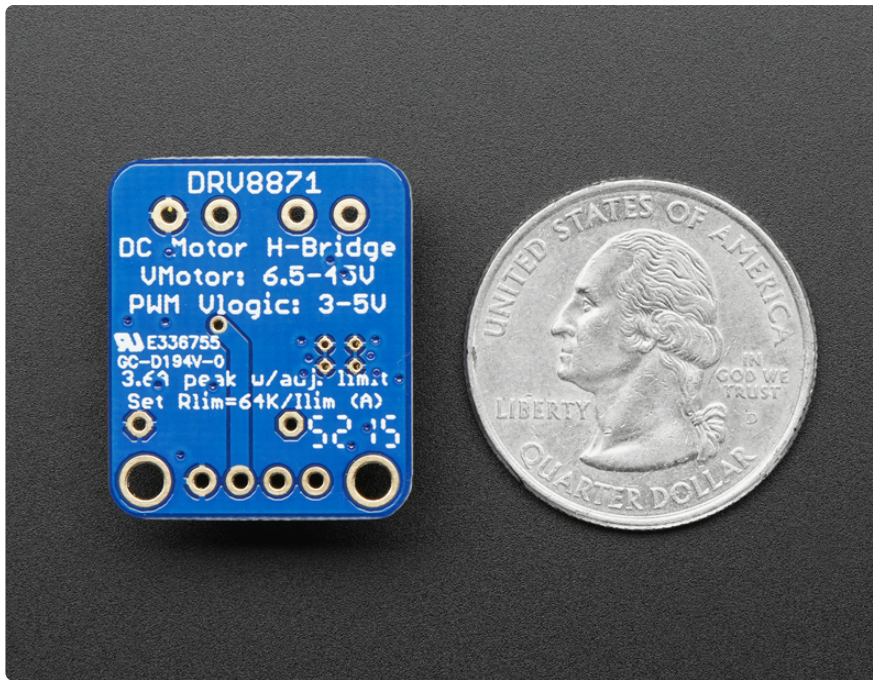
Check out the specs for the DRV8871:

- 6.5V to 45V motor power voltage

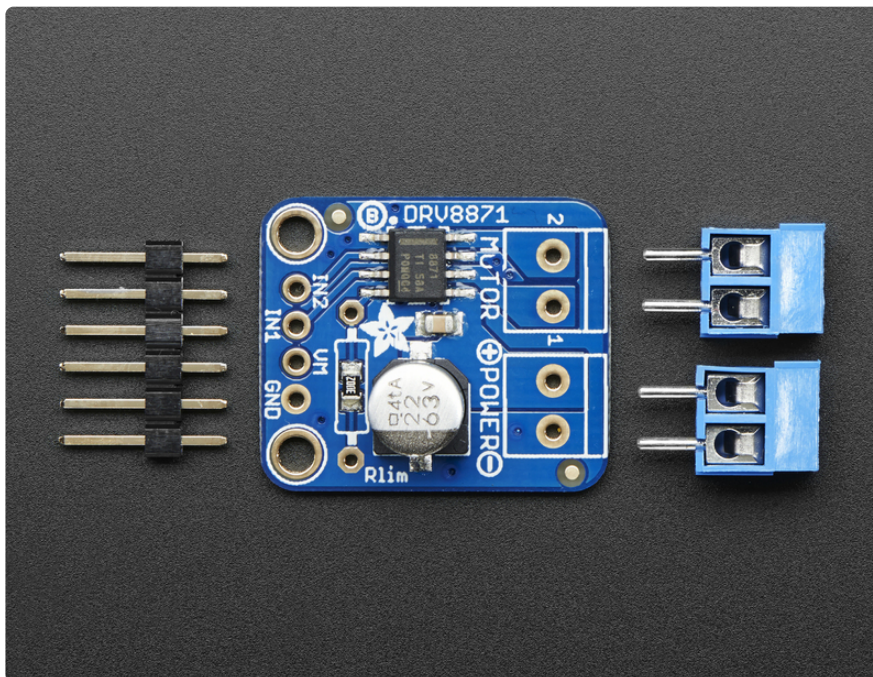
- Up to 5.5V logic level on IN pins
- 565m Ω Typical RDS(on) (high + low)
- 3.6A peak current
- PWM control
- Current limiting/regulation without an inline sense resistor
- Undervoltage lockout
- Overcurrent protection
- Thermal shutdown



Using it is super simple. Connect your motor to the **OUT** terminal block. Power the board with 6.5-45VDC power on **VMotor** and provide the H-bridge input control on **IN1** and **IN2**. You can even PWM the inputs and the driver chip will do the right thing.

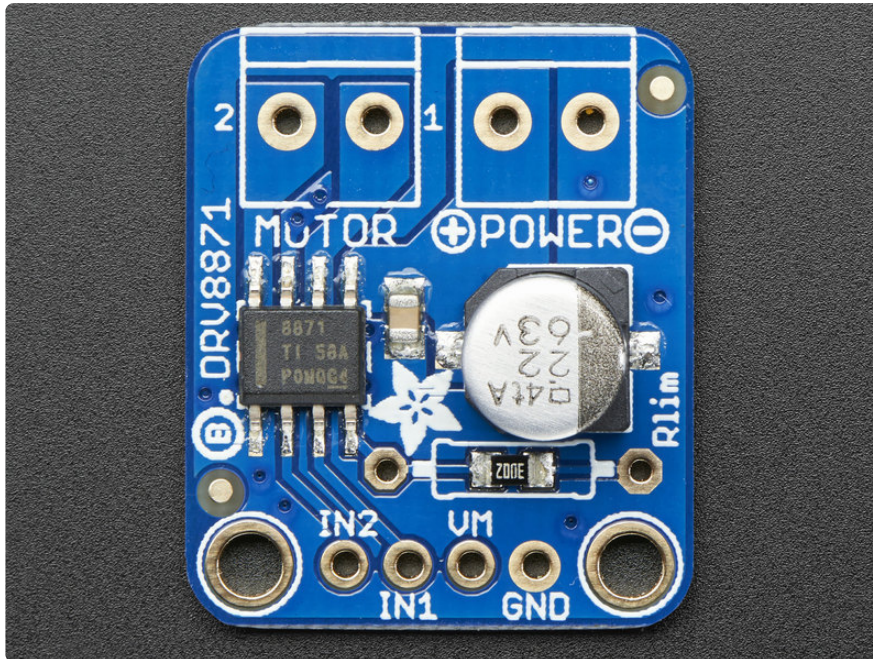


You can set the current limiting with an external resistor **Rlim**. We solder in a 30K resistor by default for a ~2A current limit, however you can remove this resistor and/or solder a resistor over it to change the resistance and change the limit.

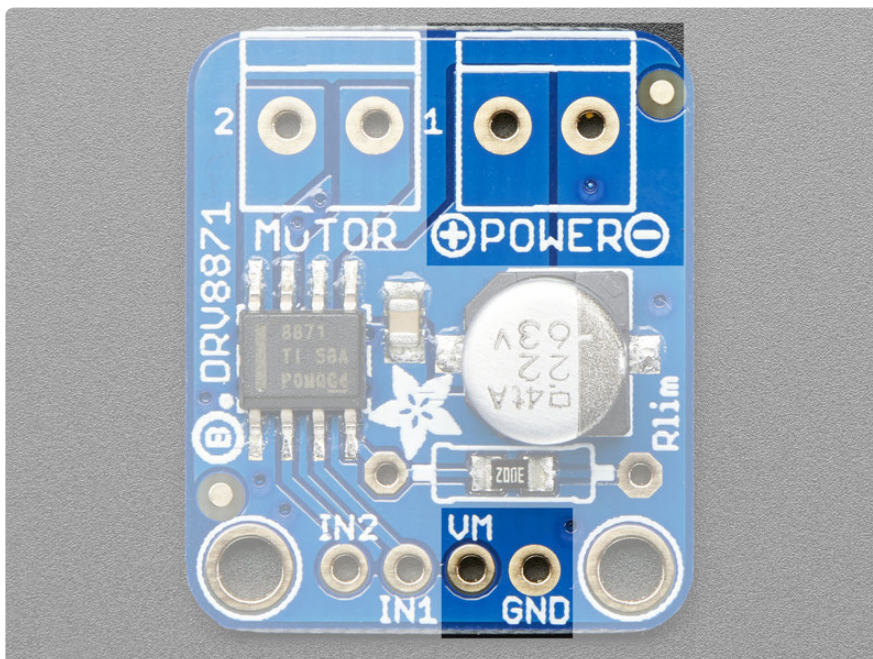


Each order comes with one fully assembled and tested motor driver breakout, two 2-pin terminal blocks and a small strip of header. Some light soldering is required to attach the header and terminal blocks but its a simple task that can be done with basic soldering equipment.

Pinouts

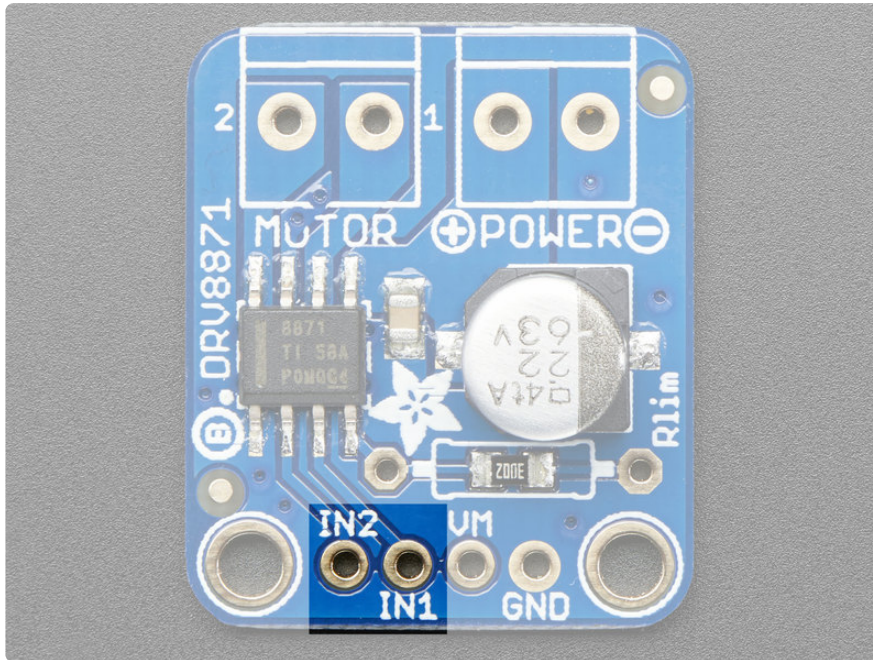


Motor power pins



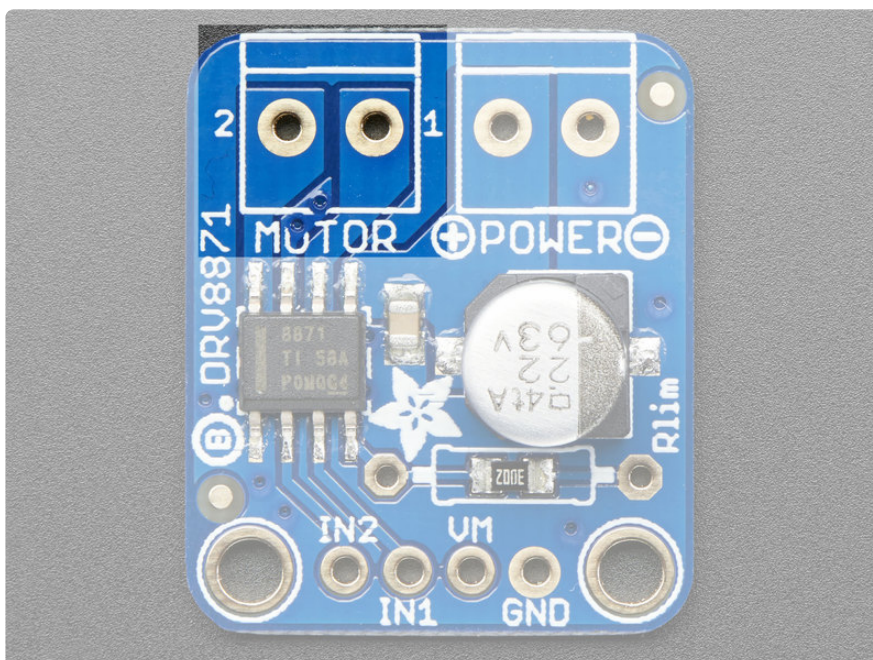
These two sets of pads are connected internally so you can use breadboard or terminal blocks to provide motor power. Use 6.5V-45VDC to power the motor and the chip. This isn't the same as the logic level of the chip, which is up to 5.5 VDC. You do not have to provide a logic level power supply to the chip, how nice is that?

Motor Input Pins

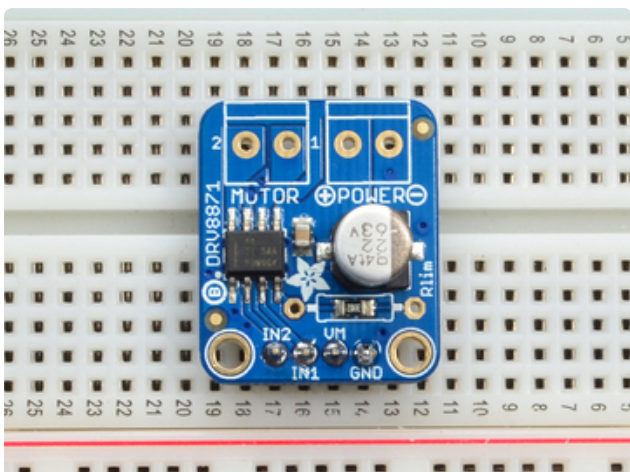
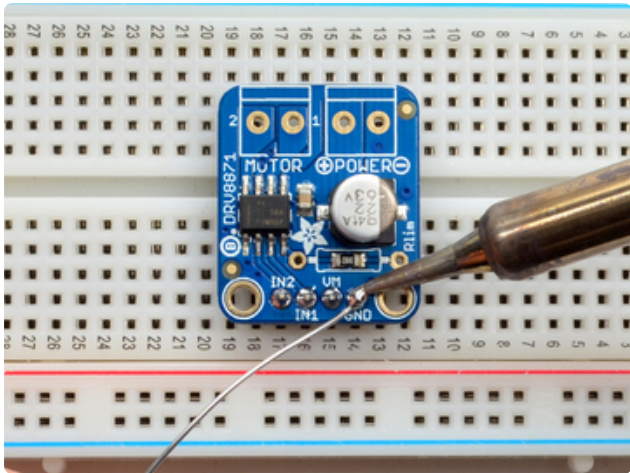
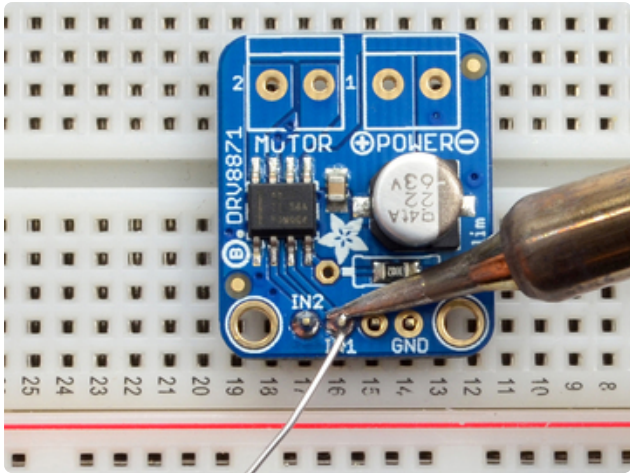
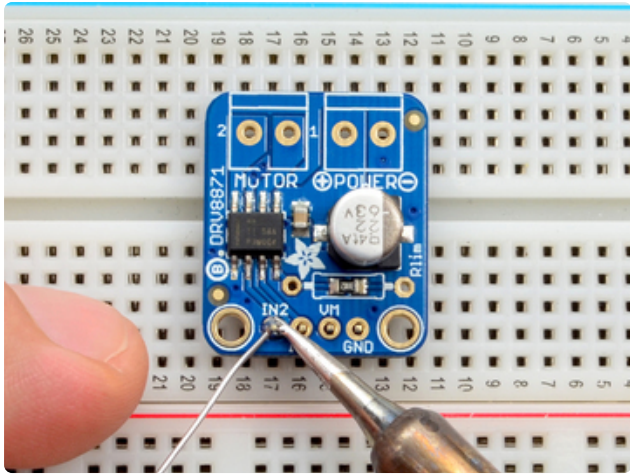


These are the inputs to the motor control. IN2 goes to OUT2, IN1 goes to OUT1. Use up to 5.5V DC logic on these pins. You can PWM the inputs up to 200KHz, but lower frequencies will be more efficient.

Motor Output



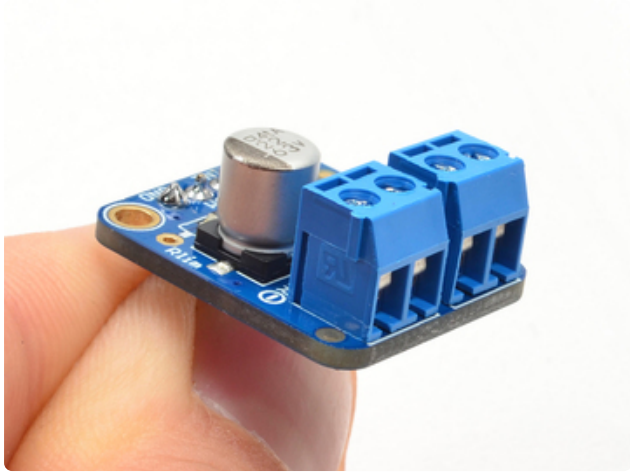
Pretty simple - this is where your motor goes! Works with any DC brushed motor. Use thick wires to avoid dropping voltage across the wire resistance



Solder!

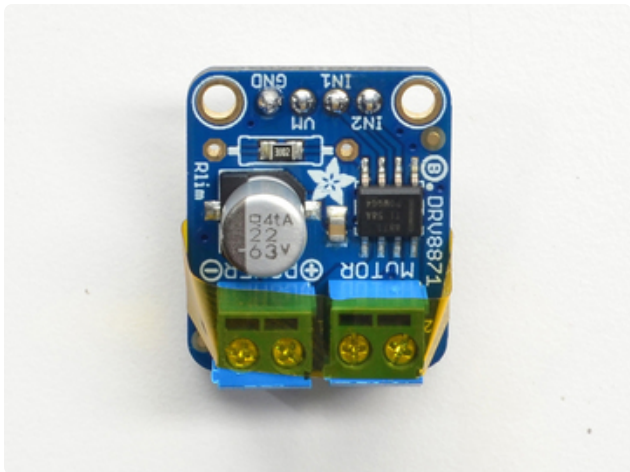
Be sure to solder all pins for reliable electrical contact.

(For tips on soldering, be sure to check out our [Guide to Excellent Soldering \(https://adafru.it/aTk\)](https://adafru.it/aTk)).

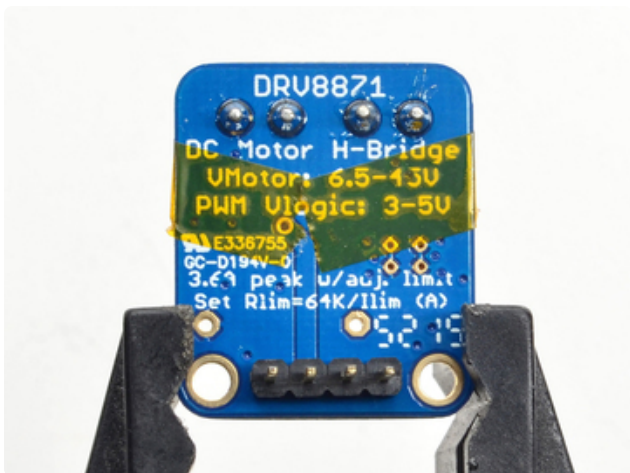
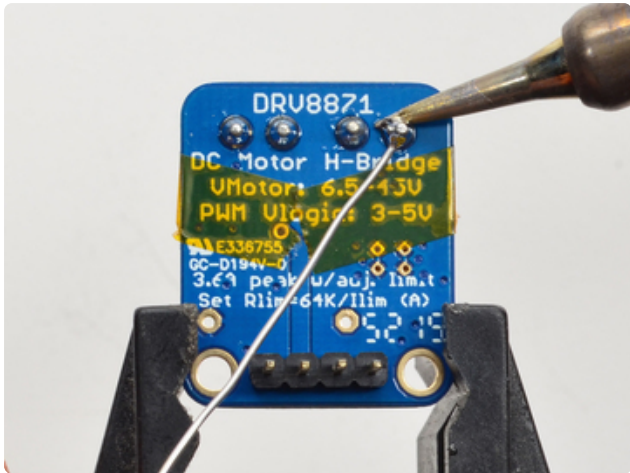
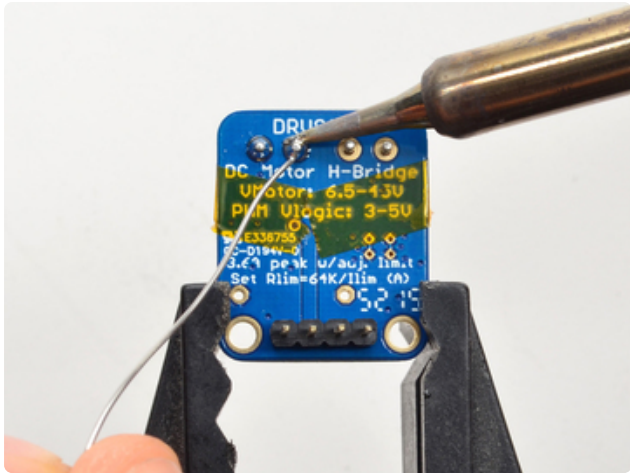


Next we will solder in the two 3.5mm terminal blocks used to connect power & the motor to the breakout board.

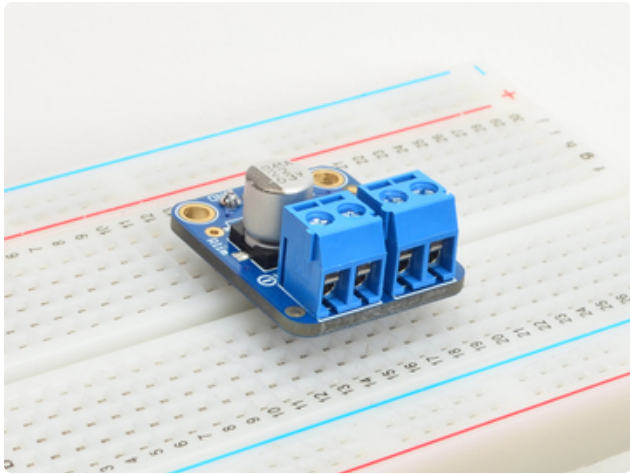
Make sure the open parts of the terminals face outwards so you can easily connect wires



To make it easier to keep these in place, you can use some tape to hold down the two header pieces. Tacky clay also works, whatever you've got handy!



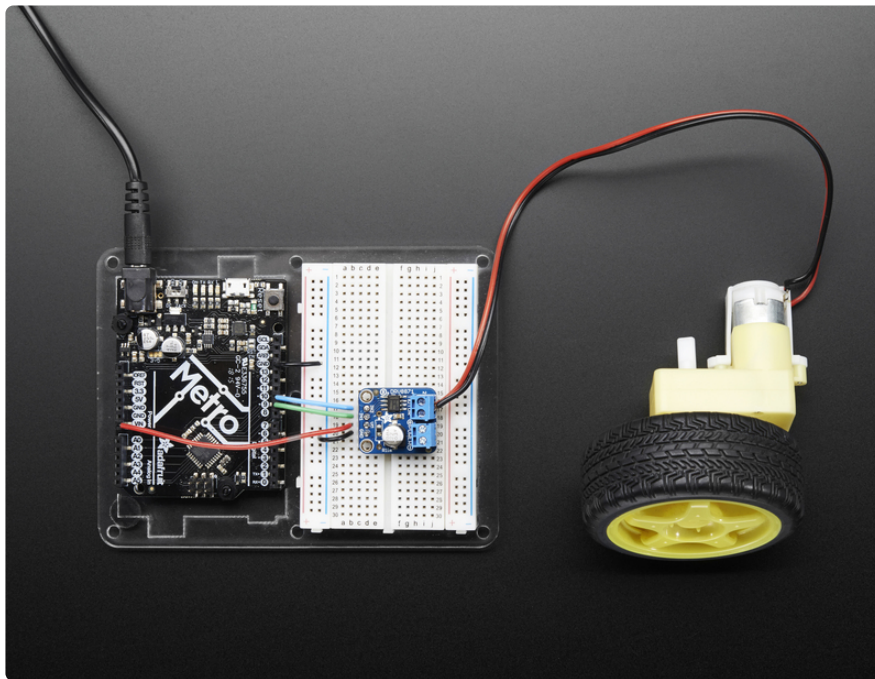
Solder in both pins of each terminal block.
You can remove the tape when done.



OK You're done! Now you can get your motors spinnin' !

Usage

Using the motor driver is really easy. Wire up the two input pins to your microcontroller's PWM outputs. We'll be using an Arduino but any microcontroller or microcomputer can be used. If you don't have PWM outputs you can also just use straight logic high and low but you won't get speed control



```
// Basic sketch for trying out the Adafruit DRV8871 Breakout

#define MOTOR_IN1 9
#define MOTOR_IN2 10

void setup() {
  Serial.begin(9600);

  Serial.println("DRV8871 test");

  pinMode(MOTOR_IN1, OUTPUT);
  pinMode(MOTOR_IN2, OUTPUT);
}
```



```

}

void loop() {

  // ramp up forward
  digitalWrite(MOTOR_IN1, LOW);
  for (int i=0; i<255; i++) {
    analogWrite(MOTOR_IN2, i);
    delay(10);
  }

  // forward full speed for one second
  delay(1000);

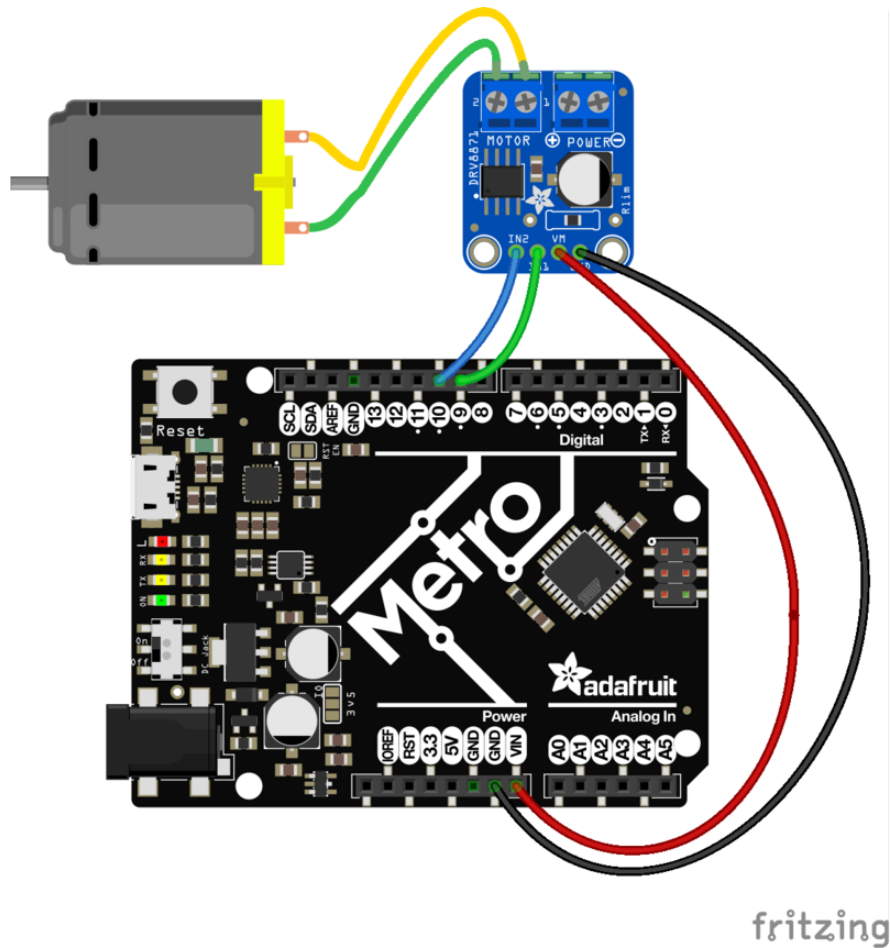
  // ramp down forward
  for (int i=255; i>=0; i--) {
    analogWrite(MOTOR_IN2, i);
    delay(10);
  }

  // ramp up backward
  digitalWrite(MOTOR_IN2, LOW);
  for (int i=0; i<255; i++) {
    analogWrite(MOTOR_IN1, i);
    delay(10);
  }

  // backward full speed for one second
  delay(1000);

  // ramp down backward
  for (int i=255; i>=0; i--) {
    analogWrite(MOTOR_IN1, i);
    delay(10);
  }
}

```

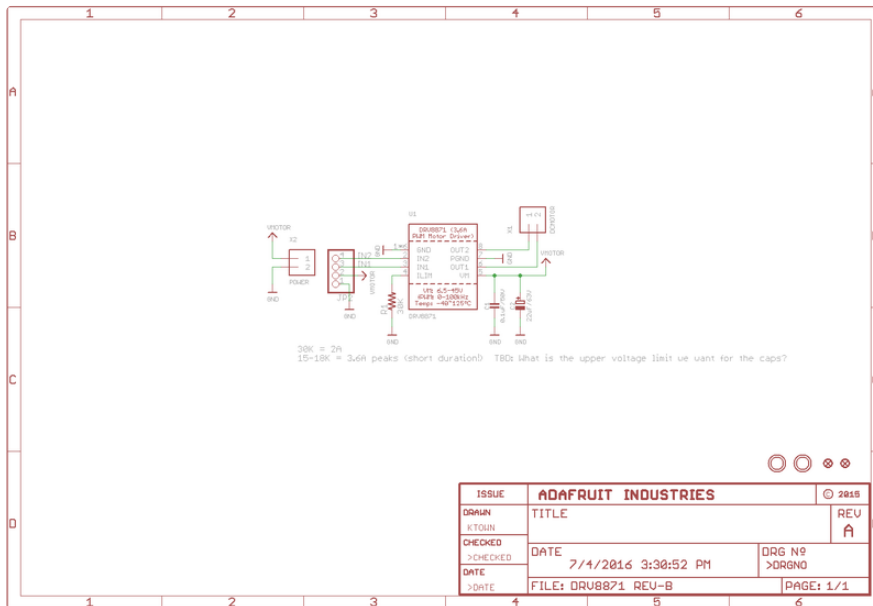


Download

Datasheets & Files

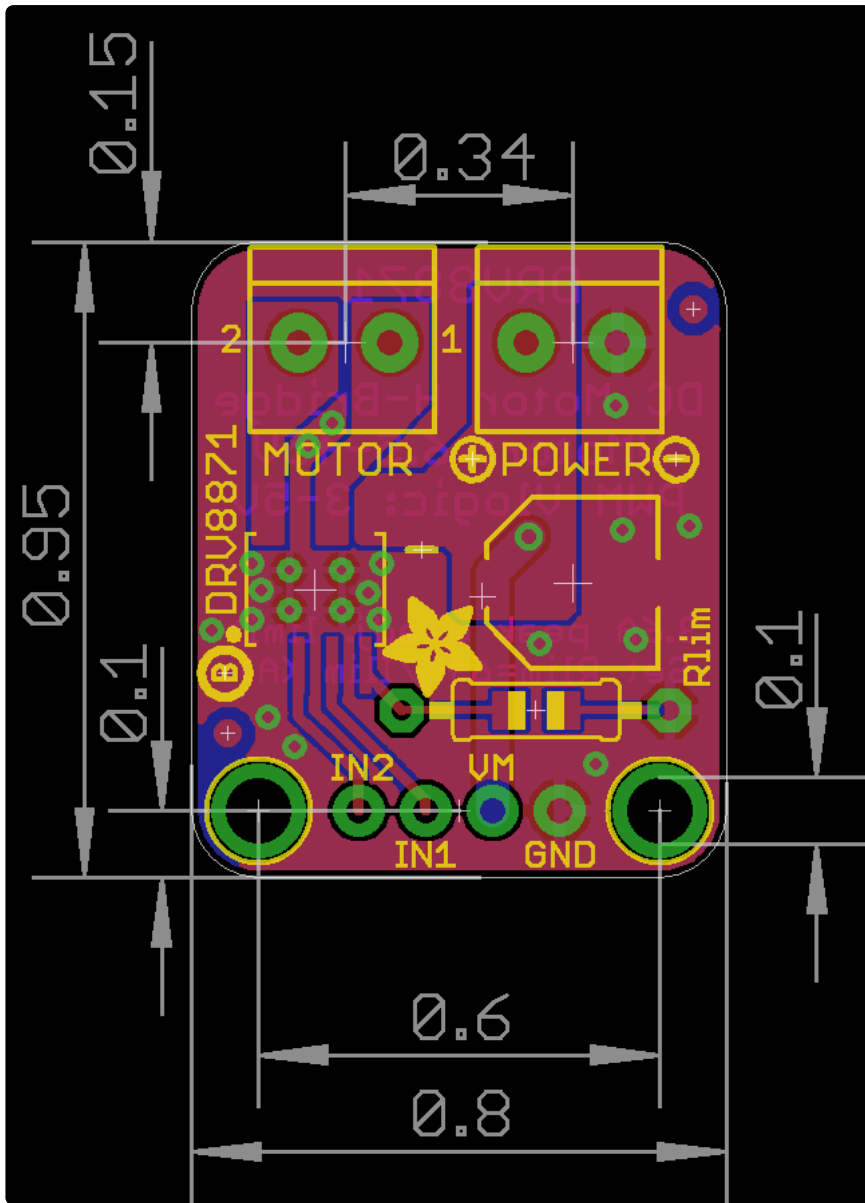
- [DRV8871 Datasheet \(http://adafru.it/31908871\)](http://adafru.it/31908871)
- [EagleCAD PCB Files on GitHub \(https://adafru.it/oET\)](https://adafru.it/oET)
- [Fritzing object in our library \(https://adafru.it/aP3\)](https://adafru.it/aP3)

Schematic



Fabrication Print

Dimensions in Inches



DRV8871 3.6-A Brushed DC Motor Driver With Internal Current Sense (PWM Control)

1 Features

- H-Bridge Motor Driver
 - Drives One DC Motor, One Winding of a Stepper Motor, or Other Loads
- Wide 6.5-V to 45-V Operating Voltage
- 565-mΩ Typical $R_{DS(on)}$ (HS + LS)
- 3.6-A Peak Current Drive
- PWM Control Interface
- Current Regulation Without a Sense Resistor
- Low-Power Sleep Mode
- Small Package and Footprint
 - 8-Pin HSOP With PowerPAD™
 - 4.9 × 6 mm
- **Integrated Protection Features**
 - VM Undervoltage Lockout (UVLO)
 - Overcurrent Protection (OCP)
 - Thermal Shutdown (TSD)
 - Automatic Fault Recovery

2 Applications

- Printers
- Appliances
- Industrial Equipment
- Other Mechatronic Applications

3 Description

The DRV8871 device is a brushed-DC motor driver for printers, appliances, industrial equipment, and other small machines. Two logic inputs control the H-bridge driver, which consists of four N-channel MOSFETs that can control motors bidirectionally with up to 3.6-A peak current. The inputs can be pulse-width modulated (PWM) to control motor speed, using a choice of current-decay modes. Setting both inputs low enters a low-power sleep mode.

The DRV8871 device has advanced current-regulation circuitry that does not use an analog voltage reference or external sense resistor. This novel solution uses a standard low-cost, low-power resistor to set the current threshold. The ability to limit current to a known level can significantly reduce the system power requirements and bulk capacitance needed to maintain stable voltage, especially for motor startup and stall conditions.

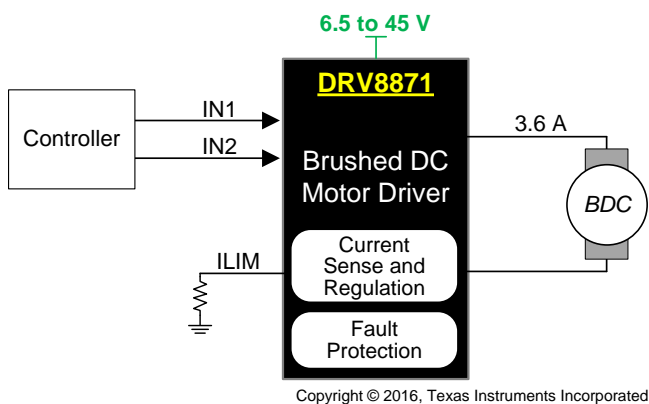
The device is fully protected from faults and short circuits, including undervoltage (UVLO), overcurrent (OCP), and overtemperature (TSD). When the fault condition is removed, the device automatically resumes normal operation.

Device Information (1)

PART NUMBER	PACKAGE	BODY SIZE (NOM)
DRV8871	HSOP (8)	4.90 mm × 6.00 mm

(1) For all available packages, see the orderable addendum at the end of the data sheet.

Simplified Schematic



Peak Current Regulation

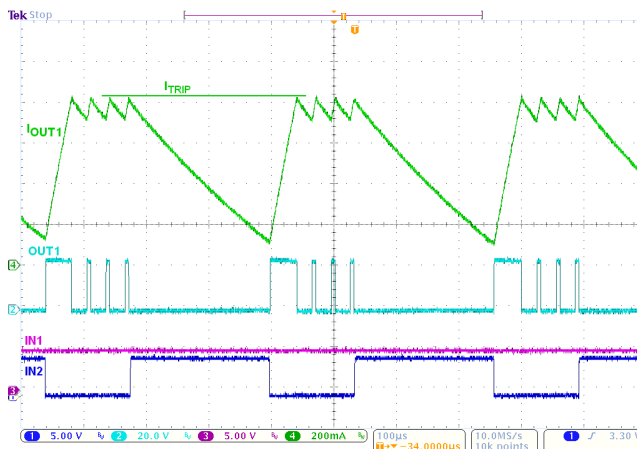


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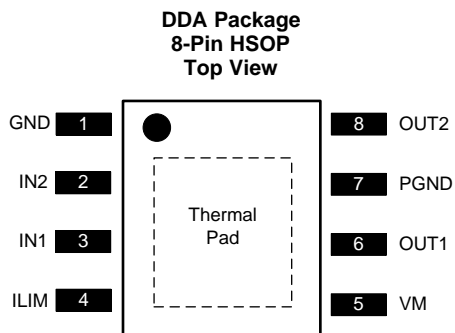
4 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision A (January 2016) to Revision B	Page
• Deleted the power supply voltage ramp rate (VM) parameter from the <i>Absolute Maximum Ratings</i> table	3
• Added the output current parameter to the <i>Absolute Maximum Ratings</i> table	3
• Added the <i>Receiving Notification of Documentation Updates</i> section	17

Changes from Original (August 2015) to Revision A	Page
• Updated the f_{PWM} max value and added a note	4
• Removed the redundant T_A condition and added $f_{PWM} = 24$ kHz	5
• Added more information to clarify how the max RMS current varies for different applications	12

5 Pin Configuration and Functions



Pin Functions

PIN		TYPE	DESCRIPTION	
NAME	NO.			
GND	1	PWR	Logic ground	Connect to board ground
ILIM	4	I	Current limit control	Connect a resistor to ground to set the current chopping threshold
IN1	3	I	Logic inputs	Controls the H-bridge output. Has internal pulldowns (see Table 1).
IN2	2			
OUT1	6	O	H-bridge output	Connect directly to the motor or other inductive load.
OUT2	8			
PGND	7	PWR	High-current ground path	Connect to board ground.
VM	5	PWR	6.5-V to 45-V power supply	Connect a 0.1- μ F bypass capacitor to ground, as well as sufficient bulk capacitance, rated for the VM voltage.
PAD	—	—	Thermal pad	Connect to board ground. For good thermal dissipation, use large ground planes on multiple layers, and multiple nearby vias connecting those planes.

6 Specifications

6.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)⁽¹⁾

	MIN	MAX	UNIT
Power supply voltage (VM)	–0.3	50	V
Logic input voltage (IN1, IN2)	–0.3	7	V
Continuous phase node pin voltage (OUT1, OUT2)	–0.7	VM + 0.7	V
Output current (100% duty cycle)	0	3.5	A
Operating junction temperature, T _J	–40	150	°C
Storage temperature, T _{stg}	–65	150	°C

(1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

6.2 ESD Ratings

		VALUE	UNIT
V _(ESD)	Electrostatic discharge	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001 ⁽¹⁾	±6000
		Charged-device model (CDM), per JEDEC specification JESD22-C101 ⁽²⁾	±750

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.

(2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

6.3 Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted)

		MIN	MAX	UNIT
V _M	Power supply voltage	6.5	45	V
V _I	Logic input voltage (IN1, IN2)	0	5.5	V
f _{PWM}	Logic input PWM frequency (IN1, IN2)	0	200 ⁽¹⁾	kHz
I _{peak}	Peak output current ⁽²⁾	0	3.6	A
T _A	Operating ambient temperature ⁽²⁾	–40	125	°C

(1) The voltages applied to the inputs should have at least 800 ns of pulse width to ensure detection. Typical devices require at least 400 ns. If the PWM frequency is 200 kHz, the usable duty cycle range is 16% to 84%.

(2) Power dissipation and thermal limits must be observed

6.4 Thermal Information

THERMAL METRIC ⁽¹⁾		DRV8871	UNIT
		DDA (HSOP)	
		8 PINS	
R _{θJA}	Junction-to-ambient thermal resistance	41.1	°C/W
R _{θJC(top)}	Junction-to-case (top) thermal resistance	53.1	°C/W
R _{θJB}	Junction-to-board thermal resistance	23.1	°C/W
ψ _{JT}	Junction-to-top characterization parameter	8.2	°C/W
ψ _{JB}	Junction-to-board characterization parameter	23	°C/W
R _{θJC(bot)}	Junction-to-case (bottom) thermal resistance	2.7	°C/W

(1) For more information about traditional and new thermal metrics, see the [Semiconductor and IC Package Thermal Metrics](#) application report.

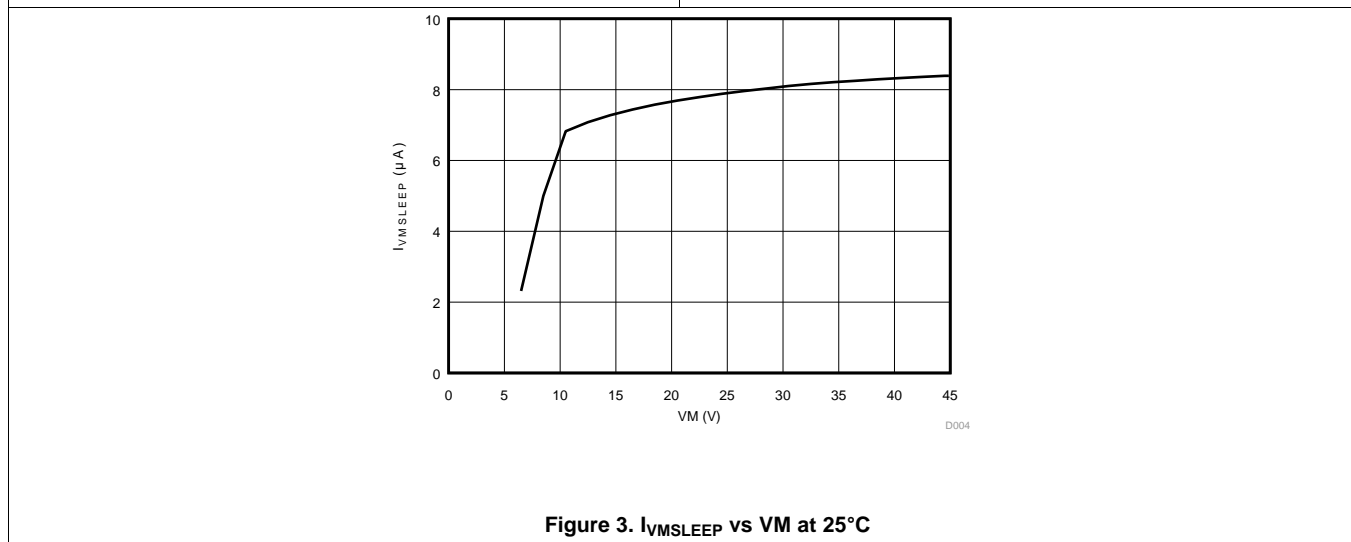
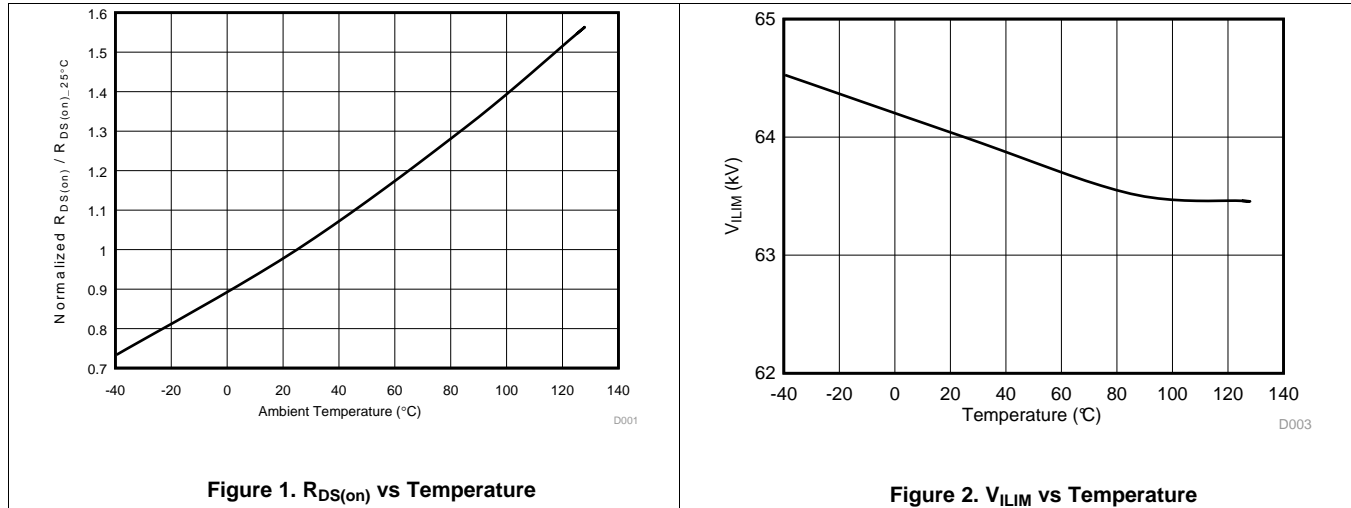
6.5 Electrical Characteristics

 $T_A = 25^\circ\text{C}$, over recommended operating conditions (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
POWER SUPPLY (VM)						
VM	VM operating voltage		6.5		45	V
I_{VM}	VM operating supply current	VM = 12 V		3	10	mA
$I_{VMSLEEP}$	VM sleep current	VM = 12 V			10	μA
$t_{ON}^{(1)}$	Turn-on time	VM > V_{UVLO} with IN1 or IN2 high		40	50	μs
LOGIC-LEVEL INPUTS (IN1, IN2)						
V_{IL}	Input logic low voltage				0.5	V
V_{IH}	Input logic high voltage		1.5			V
V_{HYS}	Input logic hysteresis			0.5		V
I_{IL}	Input logic low current	$V_{IN} = 0\text{ V}$	-1		1	μA
I_{IH}	Input logic high current	$V_{IN} = 3.3\text{ V}$		33	100	μA
R_{PD}	Pulldown resistance	To GND		100		k Ω
t_{PD}	Propagation delay	INx to OUTx change (see Figure 6)		0.7	1	μs
t_{sleep}	Time to sleep	Inputs low to sleep		1	1.5	ms
MOTOR DRIVER OUTPUTS (OUT1, OUT2)						
$R_{DS(ON)}$	High-side FET on resistance	VM = 24 V, I = 1 A, $f_{PWM} = 25\text{ kHz}$		307	360	m Ω
$R_{DS(ON)}$	Low-side FET on resistance	VM = 24 V, I = 1 A, $f_{PWM} = 25\text{ kHz}$		258	320	m Ω
t_{DEAD}	Output dead time			220		ns
V_d	Body diode forward voltage	$I_{OUT} = 1\text{ A}$		0.8	1	V
CURRENT REGULATION						
V_{ILIM}	Constant for calculating current regulation (see Equation 1)	$I_{OUT} = 1\text{ A}$	59	64	69	kV
t_{OFF}	PWM off-time			25		μs
t_{BLANK}	PWM blanking time			2		μs
PROTECTION CIRCUITS						
V_{UVLO}	VM undervoltage lockout	VM falls until UVLO triggers		6.1	6.4	V
		VM rises until operation recovers		6.3	6.5	
$V_{UV,HYS}$	VM undervoltage hysteresis	Rising to falling threshold	100	180		mV
I_{OCP}	Overcurrent protection trip level		3.7	4.5	6.4	A
t_{OCP}	Overcurrent deglitch time			1.5		μs
t_{RETRY}	Overcurrent retry time			3		ms
T_{SD}	Thermal shutdown temperature		150	175		$^\circ\text{C}$
T_{HYS}	Thermal shutdown hysteresis			40		$^\circ\text{C}$

(1) t_{ON} applies when the device initially powers up, and when it exits sleep mode.

6.6 Typical Characteristics

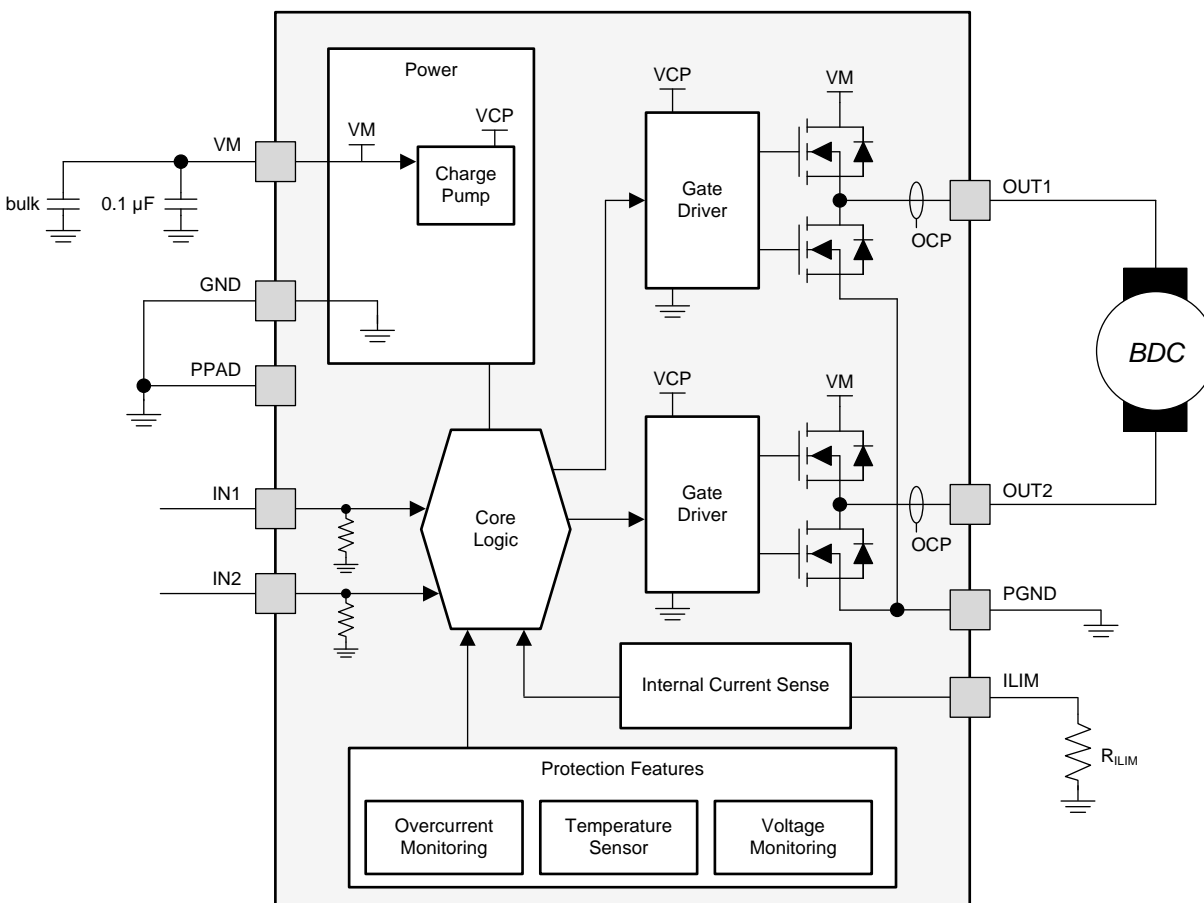


7 Detailed Description

7.1 Overview

The DRV8871 device is an optimized 8-pin device for driving brushed DC motors with 6.5 to 45 V and up to 3.6-A peak current. The integrated current regulation restricts motor current to a predefined maximum. Two logic inputs control the H-bridge driver, which consists of four N-channel MOSFETs that have a typical $R_{ds(on)}$ of 565 m Ω (including one high-side and one low-side FET). A single power input, VM, serves as both device power and the motor winding bias voltage. The integrated charge pump of the device boosts VM internally and fully enhances the high-side FETs. Motor speed can be controlled with pulse-width modulation, at frequencies between 0 to 100 kHz. The device has an integrated sleep mode that is entered by bringing both inputs low. An assortment of protection features prevent the device from being damaged if a system fault occurs.

7.2 Functional Block Diagram



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7.3 Feature Description

7.3.1 Bridge Control

The DRV8871 output consists of four N-channel MOSFETs that are designed to drive high current. They are controlled by the two logic inputs IN1 and IN2, according to Table 1.

Table 1. H-Bridge Control

IN1	IN2	OUT1	OUT2	DESCRIPTION
0	0	High-Z	High-Z	Coast; H-bridge disabled to High-Z (sleep entered after 1 ms)
0	1	L	H	Reverse (Current OUT2 → OUT1)
1	0	H	L	Forward (Current OUT1 → OUT2)
1	1	L	L	Brake; low-side slow decay

The inputs can be set to static voltages for 100% duty cycle drive, or they can be pulse-width modulated (PWM) for variable motor speed. When using PWM, it typically works best to switch between driving and braking. For example, to drive a motor forward with 50% of its max RPM, IN1 = 1 and IN2 = 0 during the driving period, and IN1 = 1 and IN2 = 1 during the other period. Alternatively, the coast mode (IN1 = 0, IN2 = 0) for *fast current decay* is also available. The input pins can be powered before VM is applied.

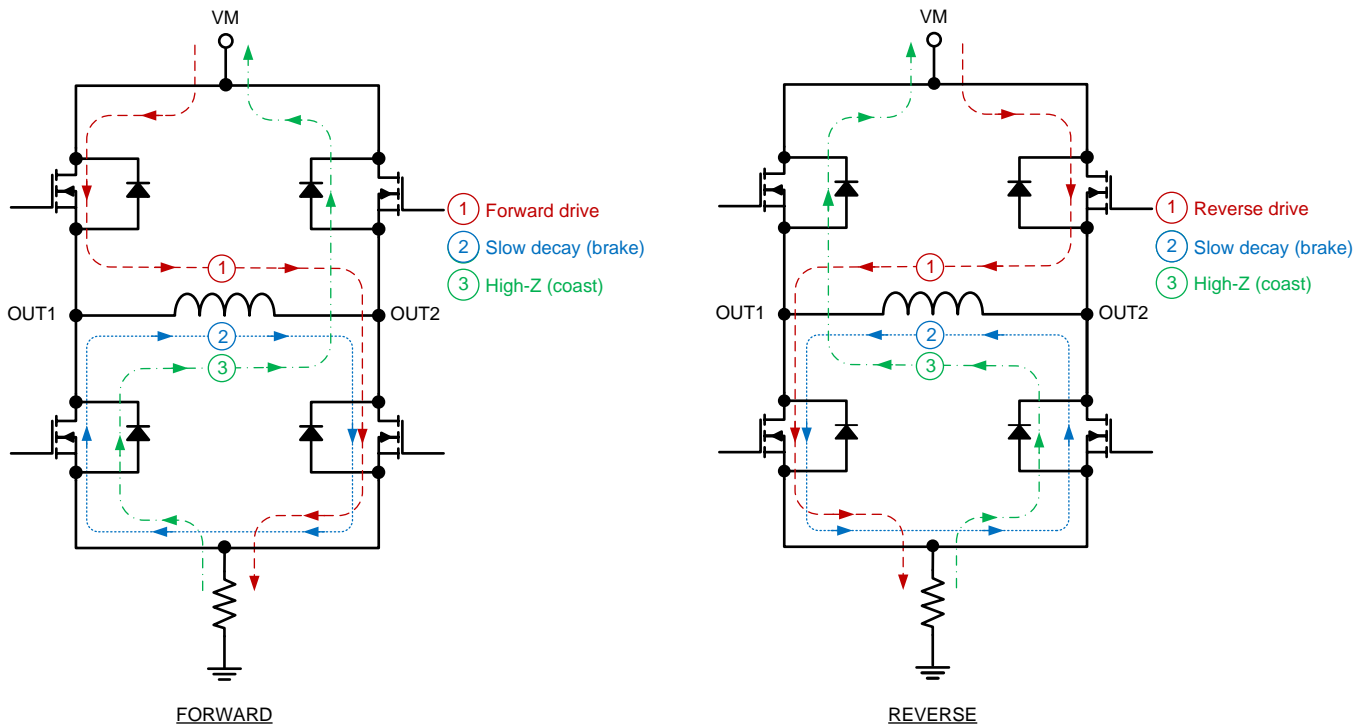


Figure 4. H-Bridge Current Paths

7.3.2 Sleep Mode

When IN1 and IN2 are both low for time t_{SLEEP} (typically 1 ms), the DRV8871 device enters a low-power sleep mode, where the outputs remain High-Z and the device uses $I_{VMSLEEP}$ (microamps) of current. If the device is powered up while both inputs are low, sleep mode is immediately entered. After IN1 or IN2 are high for at least 5 μs , the device will be operational 50 μs (t_{ON}) later.

7.3.3 Current Regulation

The DRV8871 device limits the output current based on a standard resistor attached to pin ILIM, according to this equation:

$$I_{TRIP} (A) = \frac{V_{ILIM} (kV)}{R_{ILIM} (k\Omega)} = \frac{64 (kV)}{R_{ILIM} (k\Omega)} \quad (1)$$

For example, if $R_{ILIM} = 32 \text{ k}\Omega$, the DRV8871 device limits motor current to 2 A no matter how much load torque is applied. The minimum allowed R_{ILIM} is 15 $\text{k}\Omega$. System designers should always understand the min and max I_{TRIP} , based on the R_{ILIM} resistor component tolerance and the DRV8871 specified V_{ILIM} range.

When I_{TRIP} has been reached, the device enforces slow current decay by enabling both low-side FETs, and it does this for time t_{OFF} (typically 25 μs).

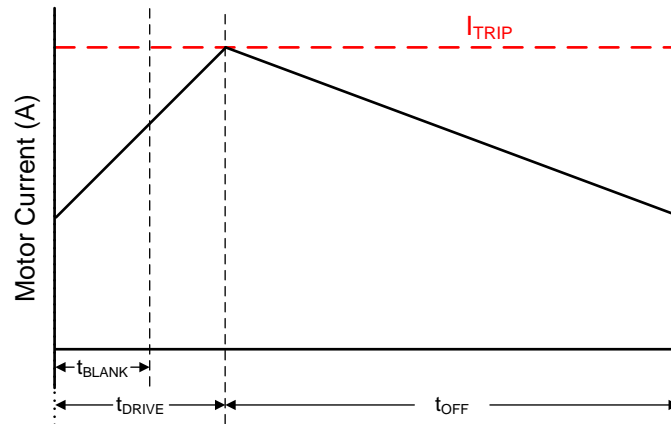


Figure 5. Current Regulation Time Periods

After t_{OFF} has elapsed, the output is re-enabled according to the two inputs INx . The drive time (t_{DRIVE}) until reaching another I_{TRIP} event heavily depends on the VM voltage, the motor's back-EMF, and the motor's inductance.

7.3.4 Dead Time

When an output changes from driving high to driving low, or driving low to driving high, dead time is automatically inserted to prevent shoot-through. t_{DEAD} is the time in the middle when the output is High-Z. If the output pin is measured during t_{DEAD} , the voltage will depend on the direction of current. If current is leaving the pin, the voltage will be a diode drop below ground. If current is entering the pin, the voltage will be a diode drop above VM. This diode is the body diode of the high-side or low-side FET.

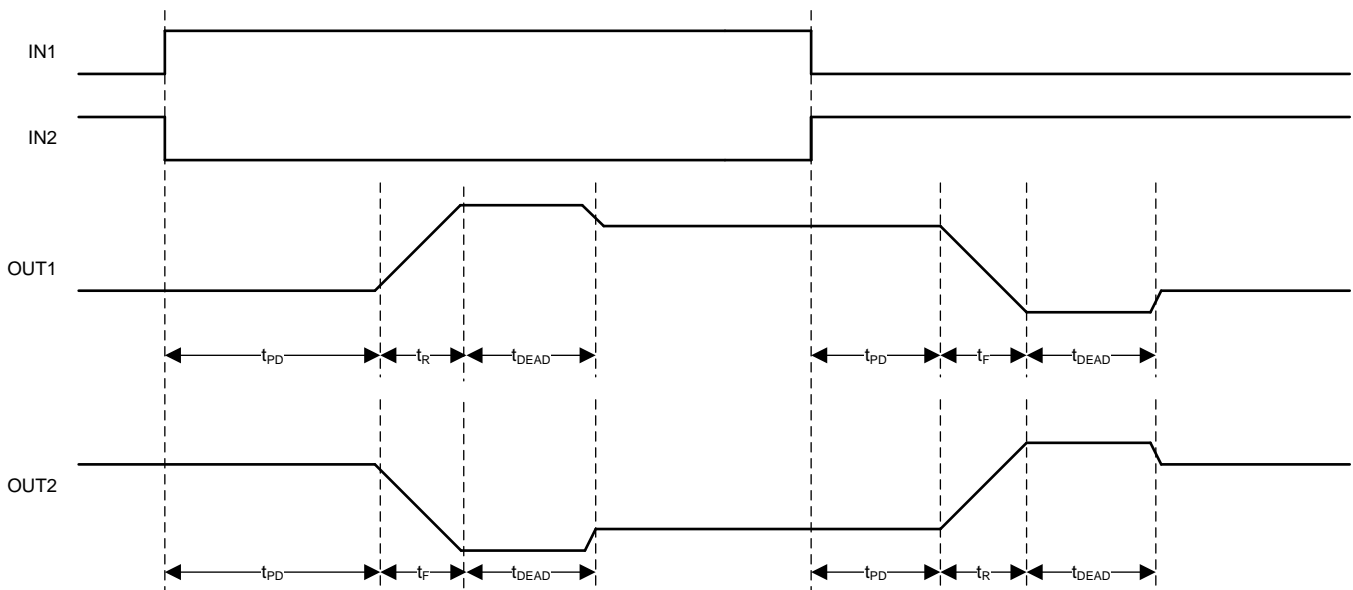


Figure 6. Propagation Delay Time

7.3.5 Protection Circuits

The DRV8871 device is fully protected against VM undervoltage, overcurrent, and overtemperature events.

7.3.5.1 VM Undervoltage Lockout (UVLO)

If at any time the voltage on the VM pin falls below the undervoltage lockout threshold voltage, all FETs in the H-bridge will be disabled. Operation will resume when VM rises above the UVLO threshold.

7.3.5.2 Overcurrent Protection (OCP)

If the output current exceeds the OCP threshold I_{OCP} for longer than t_{OCP} , all FETs in the H-bridge are disabled for a duration of t_{RETRY} . After that, the H-bridge will be re-enabled according to the state of the INx pins. If the overcurrent fault is still present, the cycle repeats; otherwise normal device operation resumes.

7.3.5.3 Thermal Shutdown (TSD)

If the die temperature exceeds safe limits, all FETs in the H-bridge will be disabled. After the die temperature has fallen to a safe level, operation automatically resumes.

Table 2. Protection Functionality

FAULT	CONDITION	H-BRIDGE BECOMES	RECOVERY
VM undervoltage lockout (UVLO)	$VM < V_{UVLO}$	Disabled	$VM > V_{UVLO}$
Overcurrent (OCP)	$I_{OUT} > I_{OCP}$	Disabled	t_{RETRY}
Thermal Shutdown (TSD)	$T_J > 150^{\circ}\text{C}$	Disabled	$T_J < T_{SD} - T_{HYS}$

7.4 Device Functional Modes

The DRV8871 device can be used in multiple ways to drive a brushed DC motor.

7.4.1 PWM With Current Regulation

This scheme uses all of the device's capabilities. I_{TRIP} is set above the normal operating current, and high enough to achieve an adequate spin-up time, but low enough to constrain current to a desired level. Motor speed is controlled by the duty cycle of one of the inputs, while the other input is static. Brake/slow decay is typically used during the off-time.

7.4.2 PWM Without Current Regulation

If current regulation is not needed, a 15-k Ω to 18-k Ω resistor should be used on pin ILIM. This mode provides the highest possible peak current: up to 3.6 A for a few hundred milliseconds (depending on PCB characteristics and the ambient temperature). If current exceeds 3.6 A, the device might reach overcurrent protection (OCP) or overtemperature shutdown (TSD). If that happens, the device disables and protects itself for about 3 ms (t_{RETRY}) and then resumes normal operation.

7.4.3 Static Inputs With Current Regulation

IN1 and IN2 can be set high and low for 100% duty cycle drive, and I_{TRIP} can be used to control the current, speed, and torque capability of the motor.

7.4.4 VM Control

In some systems it is desirable to vary VM as a means of changing motor speed. See [Motor Voltage](#) for more information.

8 Application and Implementation

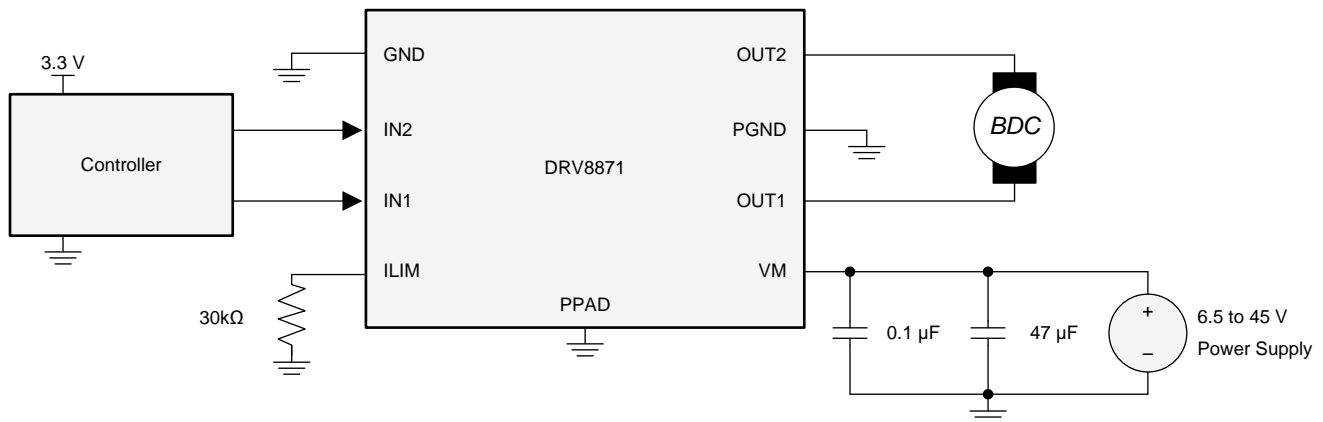
NOTE

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

8.1 Application Information

The DRV8871 device is typically used to drive one brushed DC motor.

8.2 Typical Application



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Figure 7. Typical Connections

8.2.1 Design Requirements

Table 3 lists the design parameters.

Table 3. Design Parameters

DESIGN PARAMETER	REFERENCE	EXAMPLE VALUE
Motor voltage	V_M	24 V
Motor RMS current	I_{RMS}	0.8 A
Motor startup current	I_{START}	2 A
Motor current trip point	I_{TRIP}	2.1 A
ILIM resistance	R_{ILIM}	30 kΩ
PWM frequency	f_{PWM}	5 kHz

8.2.2 Detailed Design Procedure

8.2.2.1 Motor Voltage

The motor voltage to use will depend on the ratings of the motor selected and the desired RPM. A higher voltage spins a brushed DC motor faster with the same PWM duty cycle applied to the power FETs. A higher voltage also increases the rate of current change through the inductive motor windings.

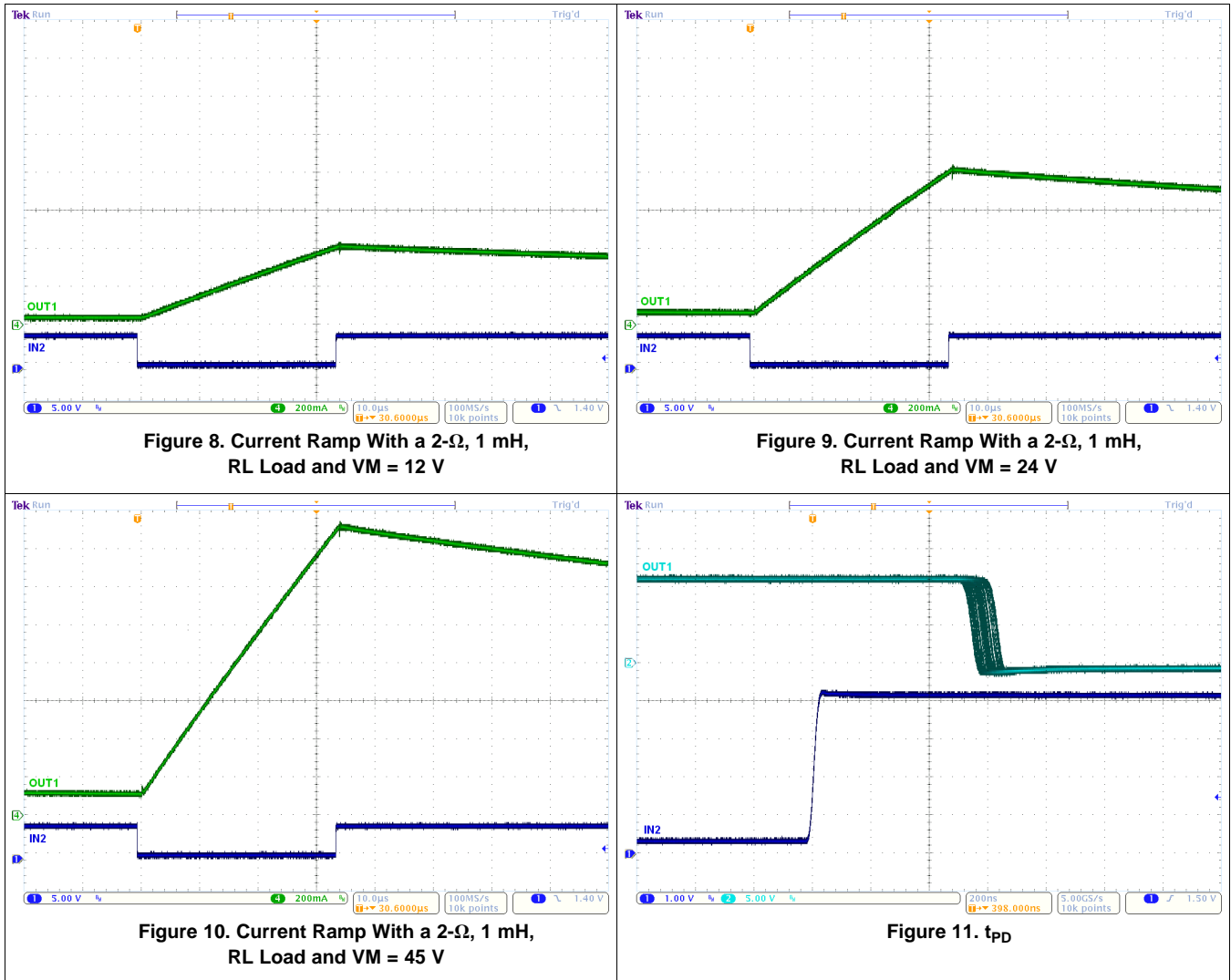
8.2.2.2 Drive Current

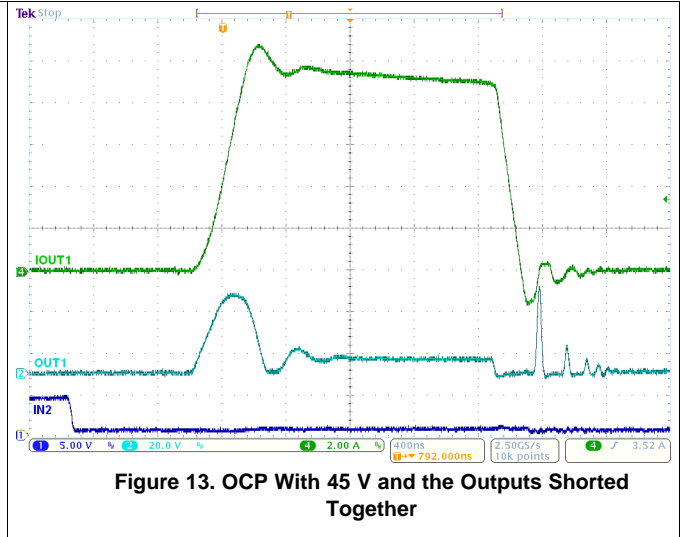
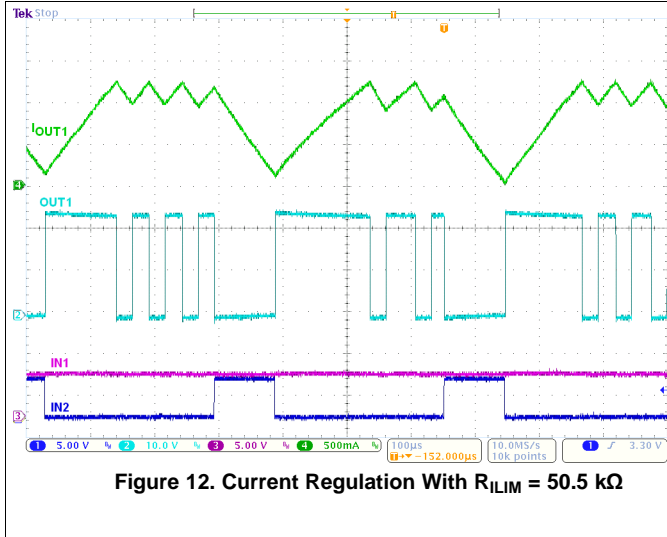
The current path is through the high-side sourcing DMOS power driver, motor winding, and low-side sinking DMOS power driver. Power dissipation losses in one source and sink DMOS power driver are shown in the following equation.

$$P_D = I^2 (R_{DS(on)Source} + R_{DS(on)Sink}) \tag{2}$$

The DRV8871 device has been measured to be capable of 2-A RMS current at 25°C on standard FR-4 PCBs. The max RMS current varies based on the PCB design, ambient temperature, and PWM frequency. Typically, switching the inputs at 200 kHz compared to 20 kHz causes 20% more power loss in heat.

8.2.3 Application Curves





9 Power Supply Recommendations

9.1 Bulk Capacitance

Having appropriate local bulk capacitance is an important factor in motor drive system design. In general, having more bulk capacitance is beneficial, while the disadvantages are increased cost and physical size.

The amount of local capacitance needed depends on a variety of factors, including:

- The highest current required by the motor system
- The power supply's capacitance and ability to source current
- The amount of parasitic inductance between the power supply and motor system
- The acceptable voltage ripple
- The type of motor used (brushed DC, brushless DC, stepper)
- The motor braking method

The inductance between the power supply and motor drive system will limit the rate current can change from the power supply. If the local bulk capacitance is too small, the system responds to excessive current demands or dumps from the motor with a change in voltage. When adequate bulk capacitance is used, the motor voltage remains stable and high current can be quickly supplied.

The data sheet generally provides a recommended value, but system-level testing is required to determine the appropriate sized bulk capacitor.

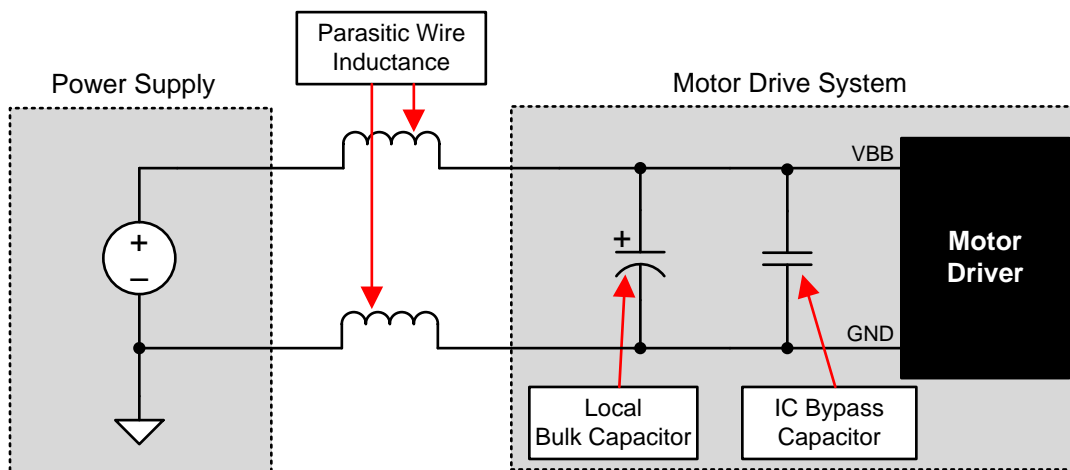


Figure 14. Example Setup of Motor Drive System With External Power Supply

The voltage rating for bulk capacitors should be higher than the operating voltage, to provide margin for cases when the motor transfers energy to the supply.

10 Layout

10.1 Layout Guidelines

The bulk capacitor should be placed to minimize the distance of the high-current path through the motor driver device. The connecting metal trace widths should be as wide as possible, and numerous vias should be used when connecting PCB layers. These practices minimize inductance and allow the bulk capacitor to deliver high current.

Small-value capacitors should be ceramic, and placed closely to device pins.

The high-current device outputs should use wide metal traces.

The device thermal pad should be soldered to the PCB top-layer ground plane. Multiple vias should be used to connect to a large bottom-layer ground plane. The use of large metal planes and multiple vias help dissipate the $I^2 \times R_{DS(on)}$ heat that is generated in the device.

10.2 Layout Example

Recommended layout and component placement is shown in [Figure 15](#)

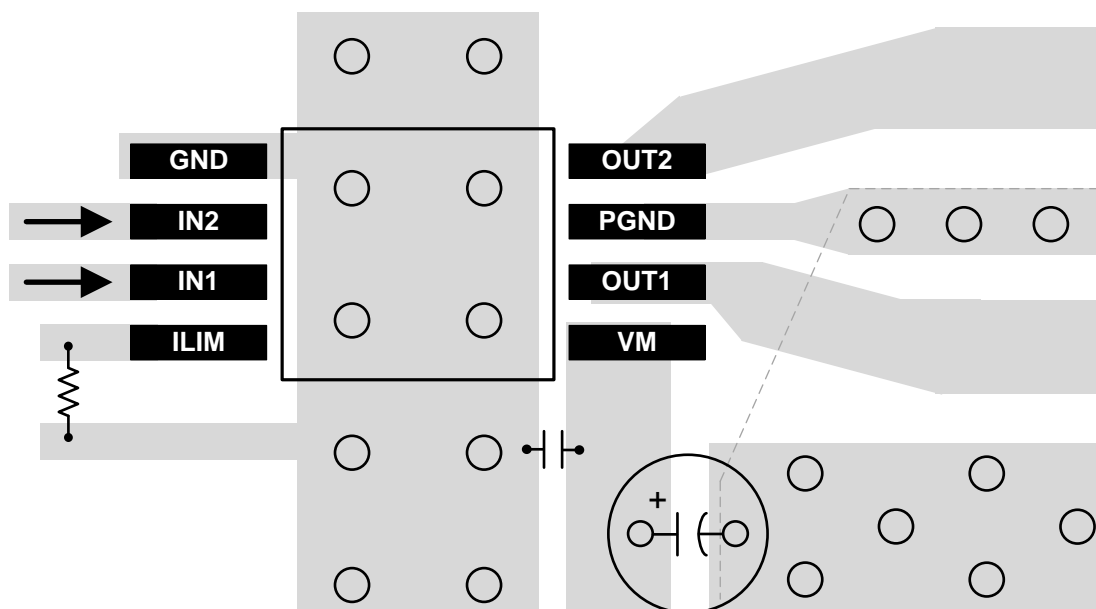


Figure 15. Layout Recommendation

10.3 Thermal Considerations

The DRV8871 device has thermal shutdown (TSD) as described in the [Thermal Shutdown \(TSD\)](#) section. If the die temperature exceeds approximately 175°C, the device is disabled until the temperature drops below the temperature hysteresis level.

Any tendency of the device to enter TSD is an indication of either excessive power dissipation, insufficient heatsinking, or too high of an ambient temperature.

10.4 Power Dissipation

Power dissipation in the DRV8871 device is dominated by the power dissipated in the output FET resistance, $R_{DS(on)}$. Use the equation in the [Drive Current](#) section to calculate the estimated average power dissipation when driving a load.

Note that at startup, the current is much higher than normal running current; this peak current and its duration must be also be considered.

Power Dissipation (continued)

The maximum amount of power that can be dissipated in the device is dependent on ambient temperature and heatsinking.

NOTE

$R_{DS(on)}$ increases with temperature, so as the device heats, the power dissipation increases. This fact must be taken into consideration when sizing the heatsink.

The power dissipation of the DRV8871 device is a function of RMS motor current and the FET resistance ($R_{DS(ON)}$) of each output.

$$\text{Power} \approx I_{RMS}^2 \times (\text{High-side } R_{DS(ON)} + \text{Low-side } R_{DS(ON)}) \quad (3)$$

For this example, the ambient temperature is 58°C, and the junction temperature reaches 80°C. At 58°C, the sum of $R_{DS(ON)}$ is about 0.72 Ω. With an example motor current of 0.8 A, the dissipated power in the form of heat will be $0.8 \text{ A}^2 \times 0.72 \text{ } \Omega = 0.46 \text{ W}$.

The temperature that the DRV8871 device reaches depends on the thermal resistance to the air and PCB. It is important to solder the device PowerPAD to the PCB ground plane, with vias to the top and bottom board layers, in order to dissipate heat into the PCB and reduce the device temperature. In the example used here, the DRV8871 device had an effective thermal resistance $R_{\theta JA}$ of 48°C/W, and:

$$T_J = T_A + (P_D \times R_{\theta JA}) = 58^\circ\text{C} + (0.46 \text{ W} \times 48^\circ\text{C/W}) = 80^\circ\text{C} \quad (4)$$

10.4.1 Heatsinking

The PowerPAD package uses an exposed pad to remove heat from the device. For proper operation, this pad must be thermally connected to copper on the PCB to dissipate heat. On a multi-layer PCB with a ground plane, this connection can be accomplished by adding a number of vias to connect the thermal pad to the ground plane.

On PCBs without internal planes, a copper area can be added on either side of the PCB to dissipate heat. If the copper area is on the opposite side of the PCB from the device, thermal vias are used to transfer the heat between top and bottom layers.

For details about how to design the PCB, refer to the TI application report, [PowerPAD™ Thermally Enhanced Package](#), and the TI application brief, [PowerPAD Made Easy™](#), available at www.ti.com. In general, the more copper area that can be provided, the more power can be dissipated.

11 Device and Documentation Support

11.1 Documentation Support

11.1.1 Related Documentation

For related documentation, see the following:

- [Current Recirculation and Decay Modes](#)
- [Calculating Motor Driver Power Dissipation](#)
- [DRV8871 Evaluation Module](#)
- [PowerPAD™ Thermally Enhanced Package](#)
- [PowerPAD™ Made Easy](#)
- [Understanding Motor Driver Current Ratings](#)

11.2 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on ti.com. In the upper right corner, click on *Alert me* to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in any revised document.

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TI E2E™ Online Community *TI's Engineer-to-Engineer (E2E) Community*. Created to foster collaboration among engineers. At e2e.ti.com, you can ask questions, share knowledge, explore ideas and help solve problems with fellow engineers.

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11.4 Trademarks

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11.5 Electrostatic Discharge Caution



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

11.6 Glossary

[SLYZ022](#) — *TI Glossary*.

This glossary lists and explains terms, acronyms, and definitions.

12 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

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