

RS8837 Low-Voltage H-Bridge Driver

1 FEATURES

- **H-Bridge Motor Driver**
 - DC Motor or Other Loads
 - Low On-Resistance: HS+LS 320mΩ
- **1.8A Maximum Drive Current**
- **Separate Motor and Logic Supply Pins:**
 - Motor VM: 0 to 12V
 - Logic VCC: 2.5V to 7V
- **Low-Power Sleep Mode With 36nA TYP Sleep Current**
- **VCC Under-Voltage Lockout**
- **Over-Current Protection**
- **Thermal Shutdown Protection**
- **Lead-Free Packages: DFN2x2-8L, SOIC-8**

2 APPLICATIONS

- DSLR Lenses
- Cameras
- Robotics
- Consumer Products, such as Toys, Smart Locks
- Medical Devices

3 DESCRIPTIONS

The RS8837 is an integrated H-bridge driver designed for dc motors and coils bi-directional turning. Usually used for small current driving, such as camera, smart locks, toys, smart sweeper, electromagnetic valve, and other low-voltage or battery-powered motion control applications.

The RS8837 can drive one DC motor or other devices like solenoids, supply up to 1.8A maximum output current. The output driver block consists of N-channel power MOSFET configured as an H-bridge to drive the motor winding. An internal charge pump generates needed gate drive voltages.

The RS8837 operates on a motor power supply voltage from 0 to 12V, and a device power supply voltage of 2.5V to 7V. Also provide internal shutdown functions for over-current protection, short-circuit protection, under-voltage lockout and over-temperature.

Device Information ⁽¹⁾

PART NUMBER	PACKAGE	BODY SIZE (NOM)
RS8837	DFN2x2-8L(8)	2.00mm×2.00mm
	SOIC-8(SOP8)	4.90mm×3.90mm

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

4 Typical Application Circuit

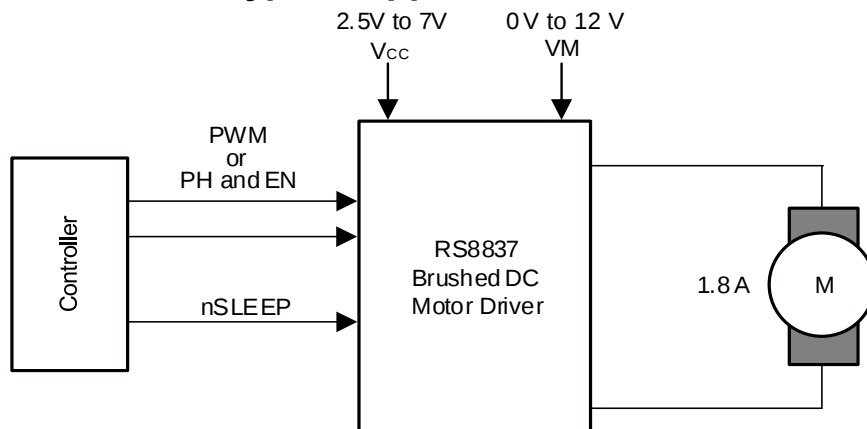


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5 Revision History

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

VERSION	Change Date	Change Item
A.0	2023/03/09	Initial version completed
A.1	2023/06/29	1.Update VCC Operating Voltage 2.Update Electrical Characteristics 3. Update VM Operating Voltage

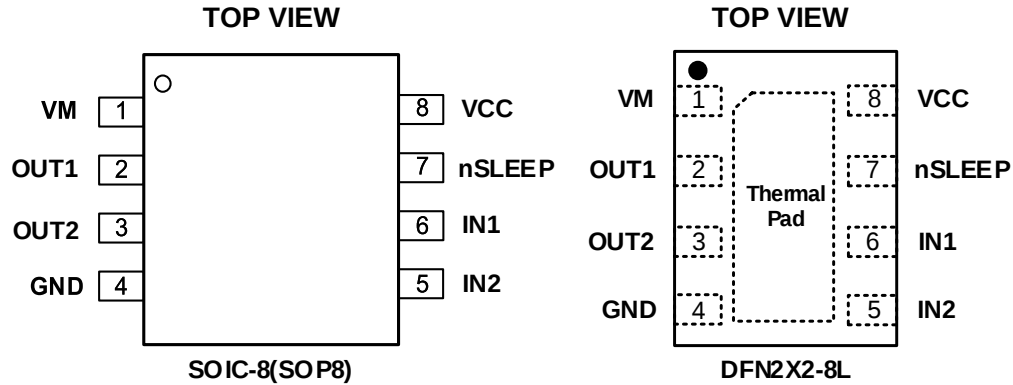
6 PACKAGE/ORDERING INFORMATION ⁽¹⁾

PRODUCT	ORDERING NUMBER	TEMPERATURE RANGE	PACKAGE LEAD	PACKAGE MARKING ⁽²⁾	PACKAGE OPTION
RS8837	RS8837YTDE8	-40°C ~ +85°C	DFN2x2-8L	8837	Tape and Reel,3000
	RS8837YK	-40°C ~ +85°C	SOIC-8(SOP8)	RS8837	Tape and Reel,4000

NOTE:

- (1) 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 right-hand navigation.
- (2) There may be additional marking, which relates to the lot trace code information(include data code and vendor code), the logo or the environmental category on the device.

7 PIN CONFIGURATIONS



Pin Description

NAME	PIN	I/O ⁽¹⁾	DESCRIPTION
	SOIC-8(SOP8)/ DFN2x2-8L		
VM	1	I	Motor power supply Bypass this pin to the GND pin with a 0.1μF ceramic capacitor rated for VM.
OUT1	2	O	Motor output
OUT2	3	O	Connect these pins to the motor winding.
GND	4	-	Device ground (This pin must be connected to ground.)
IN2	5	I	IN2 input
IN1	6	I	IN1 input
nSLEEP	7	I	Sleep mode input. When this pin is in logic low, the device enters low-power sleep mode. When this pin is logic high, the device operates normally.
VCC	8	I	Logic power supply Bypass this pin to the GND pin with a 0.1μF ceramic capacitor rated for VCC.

(1) I = Input, O = Output.

8 SPECIFICATIONS

8.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted) ⁽¹⁾⁽²⁾

		MIN	MAX	UNIT
VM	Motor power-supply voltage	-0.3	17.6	V
VCC	Logic power-supply voltage	-0.3	7	
nSLEEP	Control pin voltage	-0.5	7	
IN1, IN2	Control pin voltage	-0.5	5.5	
OUT1, OUT2	Peak drive current	Internally limited 2.7A (TYP)		A
θ_{JA}	Package thermal impedance ⁽³⁾	DFN2×2-8L	62	°C/W
		SOIC-8(SOP8)	110.88	
Temperature	Junction, T_J ⁽⁴⁾	-40	150	°C
	Storage, T_{stg}	-60	150	

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

(2) All voltages are with respect to the GND pin.

(3) The package thermal impedance is calculated in accordance with JESD-51.

(4) The maximum power dissipation is a function of $T_{J(MAX)}$, $R_{\theta JA}$, and T_A . The maximum allowable power dissipation at any ambient temperature is $P_D = (T_{J(MAX)} - T_A) / R_{\theta JA}$. All numbers apply for packages soldered directly onto a PCB.

8.2 ESD Ratings

The following ESD information is provided for handling of ESD-sensitive devices in an ESD protected area only.

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001 ⁽¹⁾	±4000	V
		Charged-device model (CDM), per ANSI/ESDA/JEDEC JS-002 ⁽²⁾	±1500	
		Machine Model (MM)	±200	

(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.



ESD SENSITIVITY CAUTION

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

8.3 Recommended Operating Conditions

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

Characteristics	Symbol	MIN	NOM	MAX	UNIT
Motor power supply voltage	VM	0		12	V
Logic power supply voltage	VCC	2.5		7	V
Motor peak current	I_{OUT}	0		1.8	A
Externally applied PWM frequency	f_{PWM}	0		250	KHz
Logic level input voltage	V_{LOGIC}	-0.5		5.5	V
Operating Temperature	T_A	-40		85	°C

(1) Power dissipation and thermal limits must be observed.

8.4 Electrical Characteristics

T_A = +25°C, over recommended operating condition unless otherwise noted. ⁽¹⁾

SYMBOL	PARAMETER	TEST CONDITION	MIN ⁽²⁾	TYP ⁽³⁾	MAX ⁽²⁾	UNIT
POWER SUPPLIES (VM, VCC)						
VM	VM Operating Voltage		0		12	V
I _{VM}	VM Operating Supply Current	VM=5V, VCC=3V, No PWM		150	600	uA
		VM=5V, VCC=3V, 50kHz PWM		510	600	uA
I _{VMQ}	VM Sleep Mode Supply Current	VM=5V, VCC=3V, nSLEEP = 0		35	1000	nA
VCC	VCC Operating Voltage		2.5		7	V
I _{VCC}	VCC Operating Supply Current	VM=5V, VCC=3V, No PWM		260	350	uA
		VM=5V, VCC=3V, 50kHz PWM		280	350	uA
I _{VCCQ}	VCC Sleep Mode Supply Current	VM=5V, VCC=3V, nSLEEP = 0		1	1000	nA
CONTROL INPUTS (IN1, IN2, nSLEEP)						
V _{IH}	Input Logic-High Voltage Rising Threshold	nSLEEP	1.3			V
		IN1, IN2	0.7×VCC			V
V _{IL}	Input Logic-Low Voltage Falling Threshold	nSLEEP			0.8	V
		IN1, IN2			0.3×VCC	V
I _{IL}	Input Logic Low Current	V _{IN} =0V			1	uA
I _{IH}	Input Logic High Current	V _{IN} =3.3V		30		uA
R _{PD}	Pulldown Resistance			100		kΩ
MOTOR DRIVER OUTPUTS (OUT1, OUT2)						
R _{DS(ON)}	HS + LS FET On-Resistance	VM=5V, VCC =3V, I _O =0.8A, T _J =25°C		320	500	mΩ
I _{OFF}	Off-State Leakage Current	V _{OUT} = 0V	-200		200	nA
PROTECTION CIRCUITS						
V _{UVLO}	VCC Undervoltage Lockout	VCC rising		2.0		V
		VCC falling		2.0		V
I _{OC}	Overcurrent Protection Trip Level	VM=5V, VCC =3V	2.05	2.7	3.15	A
t _{DEG}	Overcurrent Deglitch Time	VM=5V, VCC =3V		1		us
t _{RETRY}	Overcurrent Retry Time	VM=5V, VCC =3V		1.2		ms
T _{TSD}	Thermal Shutdown Temperature	T _J temperature		160		°C
T _{RES}	Thermal Resume Temperature			120		°C

NOTE:

- (1) Electrical table values apply only for factory testing conditions at the temperature indicated. Factory testing conditions result in very limited self-heating of the device.
- (2) Limits are 100% production tested at 25°C. Limits over the operating temperature range are ensured through correlations using statistical quality control (SQC) method.
- (3) Typical values represent the most likely parametric norm as determined at the time of characterization. Actual typical values may vary over time and will also depend on the application and configuration.

8.5 Timing Requirements

$T_A=25^{\circ}\text{C}$, $V_M=5\text{V}$, $V_{CC}=3\text{V}$, $R_L=20\Omega$ between OUT1 and OUT2.

NUM	PARAMETER	TEST CONDITION	MIN ⁽²⁾	TYP ⁽³⁾	MAX ⁽²⁾	UNIT
1	t_1	Output enable time IN1 high and IN2 low to OUT1= $0.97 \times V_M$		285		ns
2	t_2	Output disable time IN1 low and IN2 low to OUT2= $0.9 \times V_M$		170		ns
3	t_3	Delay time, INx high to OUTx high IN1 low IN2 high to OUT2= $0.5 \times V_M$		125		ns
4	t_4	Delay time, INx low to OUTx low IN1 low IN2 low to OUT1= $0.5 \times V_M$		110		ns
5	t_5	Output rise time OUT1= $0.2 \times V_M$ to OUT1= $0.8 \times V_M$		165		ns
6	t_6	Output fall time OUT2= $0.8 \times V_M$ to OUT1= $0.2 \times V_M$		40		ns
t_{Wake}	t_{Wake}	Wake time, nSLEEP rising edge to part active		9		us

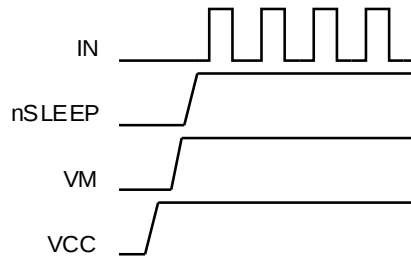


Figure 1. power-on sequence

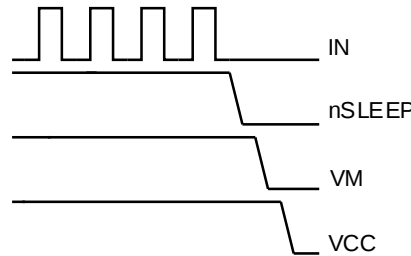


Figure 2. power-down sequence

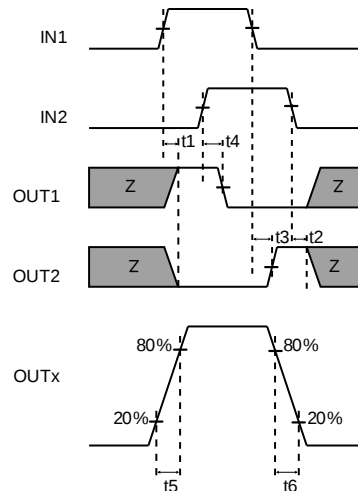


Figure 3. Input and Output Timing for RS8837

8.6 Typical Characteristics

NOTE: The graphs and tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only.

At $T_A = +25^\circ\text{C}$, unless otherwise noted.

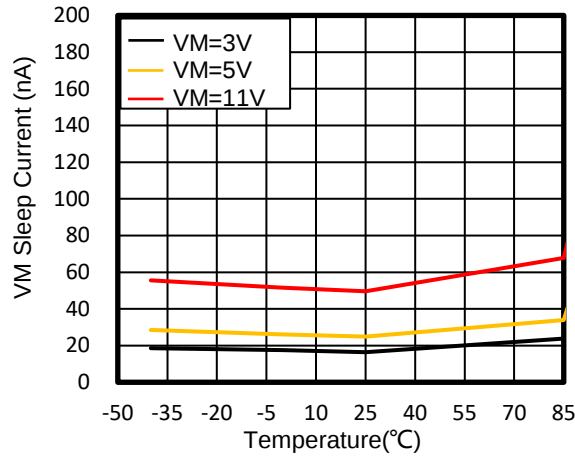


Figure 4. I_{VMQ} vs Temperature

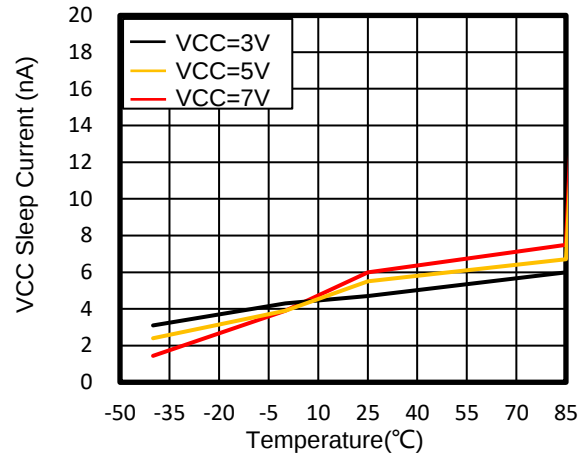


Figure 5. I_{VCCQ} vs Temperature

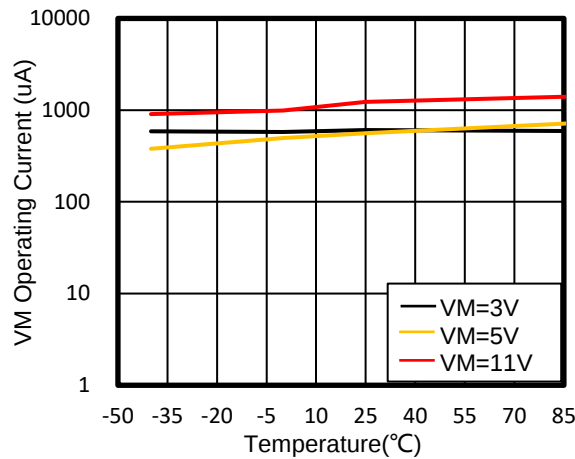


Figure 6. I_{VM} vs Temperature (50-kHz PWM)

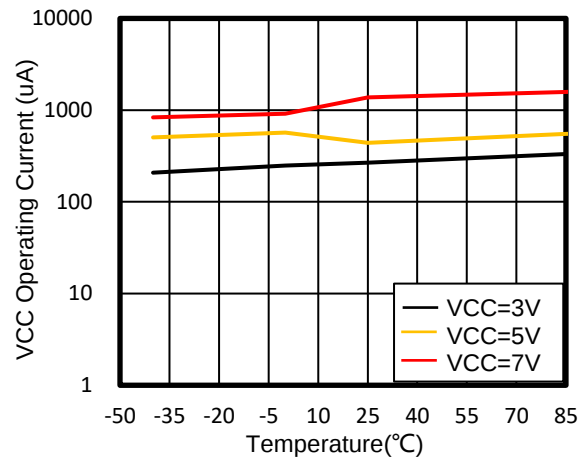


Figure 7. I_{VCC} vs Temperature (50-kHz PWM)

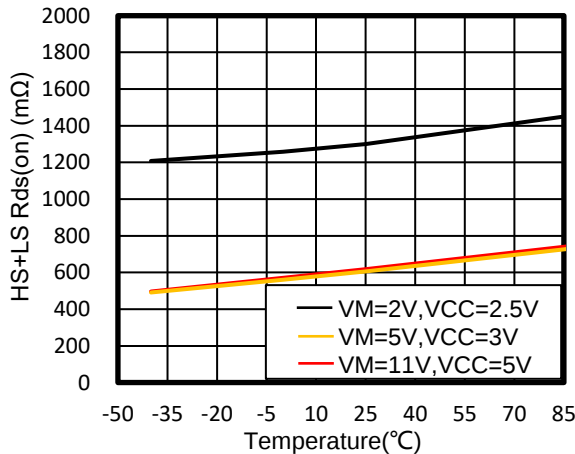


Figure 8. HS+LS $R_{ds(on)}$ vs Temperature

9 DETAILED DESCRIPTION

9.1 Overview

The RS8837 is an H-bridge driver that can drive one dc motor or other devices like solenoids. The outputs are controlled using either a PWM interface (IN1 and IN2). A low-power sleep mode is included, which can be enabled using the nSLEEP pin.

These devices greatly reduce the component count of motor driver systems by integrating the necessary driver FETs and FET control circuitry into a single device. In addition, the RS8837 adds protection features beyond traditional discrete implementations: undervoltage lockout, overcurrent protection, and thermal shutdown.

9.2 Functional Block Diagram

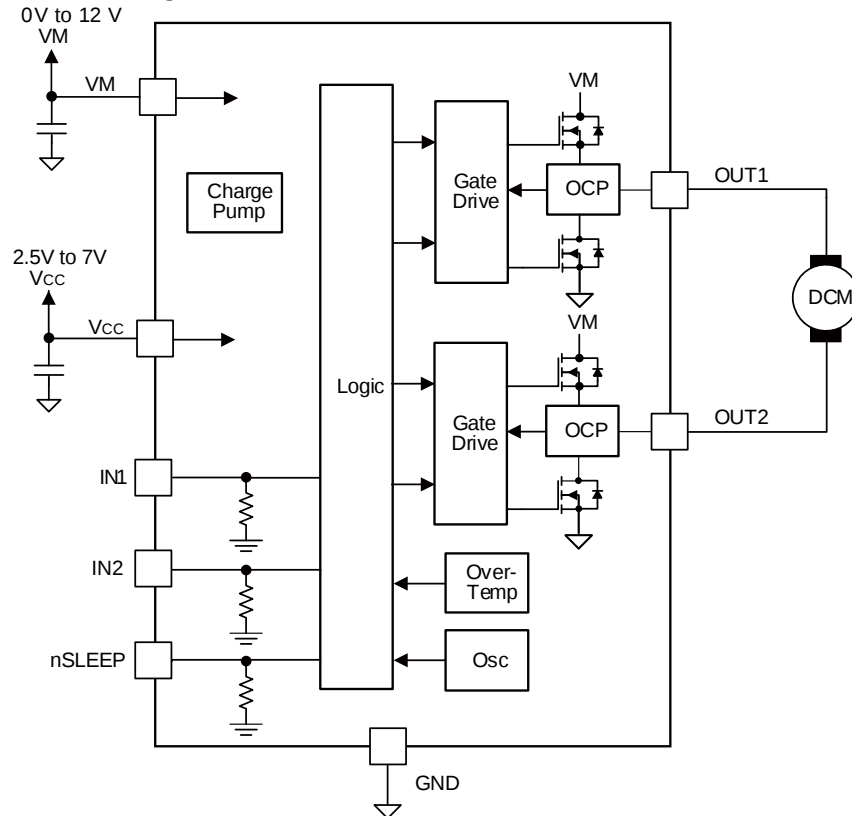


Figure 9. RS8837 Functional Block Diagram

9.3 Feature Description

9.3.1 Bridge Control

The RS8837 device is controlled using a PWM input interface, also called an IN-IN interface. Each output is controlled by a corresponding input pin. Table 1 shows the logic for the RS8837 device.

Table 1. RS8837 Device Logic

nSLEEP	IN1	IN2	OUT1	OUT2	FUNCTION (DC MOTOR)
0	X	X	Z	Z	Coast
1	0	0	Z	Z	Coast
1	0	1	L	H	Reverse
1	1	0	H	L	Forward
1	1	1	L	L	Brake

9.3.2 Sleep Mode

If the nSLEEP pin is brought to a logic-low state, the RS8837 enters a low-power sleep mode. In this state, all unnecessary internal circuitry is powered down.

9.3.3 Power Supplies and Input Pins

The input pins can be driven within the recommended operating conditions with or without the VCC, VM, or both power supplies present. No leakage current path will exist to the supply. Each input pin has a weak pulldown resistor (approximately 100 kΩ) to ground.

The VCC and VM supplies can be applied and removed in any order. When the VCC supply is removed, the device enters a low-power state and draws very little current from the VM supply. The VCC and VM pins can be connected together if the supply voltage is between 2.5V and 7 V.

The VM voltage supply does not have any undervoltage-lockout protection (UVLO) so as long as $VCC > 2.0\text{ V}$; the internal device logic remains active, which means that the VM pin voltage can drop to 0 V. However, the load cannot be sufficiently driven at low VM voltages.

9.3.4 Protection Circuits

The RS8837 is fully protected against VCC undervoltage, overcurrent, and overtemperature events.

9.3.5 VCC Undervoltage Lockout

If at any time the voltage on the VCC pin falls below the undervoltage lockout threshold voltage, all FETs in the H-bridge are disabled. Operation resumes when the VCC pin voltage rises above the UVLO threshold.

9.3.6 Overcurrent Protection

An analog current-limit circuit on each FET limits the current through the FET by removing the gate drive. If this analog current limit persists for longer than t_{DEG} , all FETs in the H-bridge are disabled. Operation resumes automatically after t_{RETRY} has elapsed. Overcurrent conditions are detected on both the high-side and low-side FETs. A short to the VM pin, GND, or from the OUT1 pin to the OUT2 pin results in an overcurrent condition.

9.3.7 Thermal Shutdown

If the die temperature exceeds safe limits, all FETs in the H-bridge are disabled. After the die temperature falls to a safe level, operation automatically resumes.

Table 2. Fault Behavior

FAULT	CONDITION	H-BRIDGE	RECOVERY
VCC undervoltage	$VCC < 1.7\text{V}$	Disabled	$VCC > 2.5\text{V}$
Over current	$I_{OUT} > 2.7\text{A (TYP)}$	Disabled	t_{RETRY} elapses
Thermal Shutdown	$T_J > 150^\circ\text{C(TYP)}$	Disabled	$T_J < 110^\circ\text{C}$

9.4 Device Functional Modes

The RS8837 is active unless the nSLEEP pin is brought logic low. In sleep mode, the H-bridge FETs are disabled Hi-Z. The RS8837 is brought out of sleep mode automatically if nSLEEP is brought logic high.

The H-bridge outputs are disabled during undervoltage lockout, overcurrent, and overtemperature fault conditions.

Table 3. Operation Modes

MODE	CONDITION	H-BRIDGE
Operating	nSLEEP pin=1	Operating
Sleep mode	nSLEEP pin=0	Disabled
Fault encountered	Any fault condition met	Disabled

10 Application and Implementation

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

10.1 Application Information

The RS8837 is device is used to drive one dc motor or other devices like solenoids. The following design procedure can be used to configure the RS8837.

10.2 Typical Application

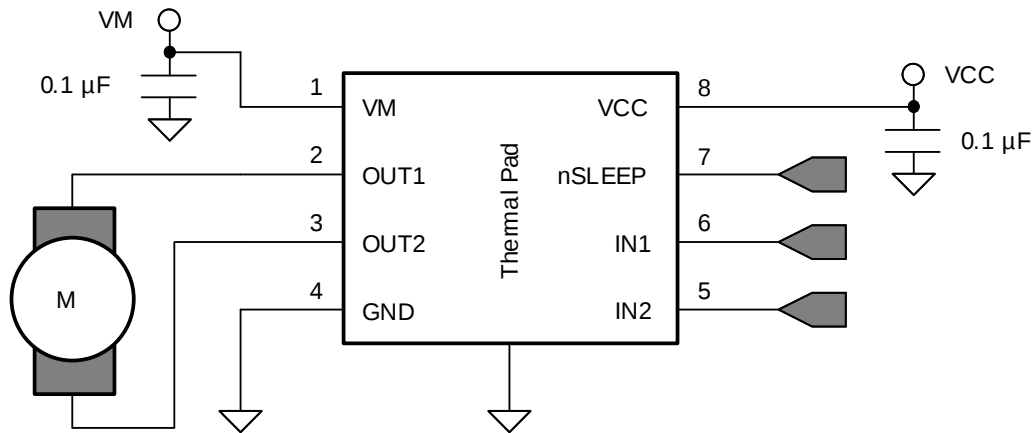


Figure 10. Schematic of RS8837 Application

10.3 Design Requirements

Table 4 lists the required parameters for a typical usage case.

Table 4. System Design Requirements

DESIGN PARAMETER	REFERENCE	EXAMPLE VALUE
Motor supply voltage	VM	9V
Logic supply voltage	VCC	3.3V
Target rms current	I _{OUT}	0.8A

10.4 Detailed Design Procedure

10.4.1 Motor Voltage

The appropriate motor voltage depends 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.

10.4.2 Low-Power Operation

When entering sleep mode, Runic recommends setting all inputs as a logic low to minimize system power.

11 Power Supply Recommendations

11.1 Bulk Capacitance

Having appropriate local bulk capacitance is an important factor in motor-drive system design. It is generally beneficial to have more bulk capacitance, 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 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 limits the rate at which 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 size of bulk capacitor.

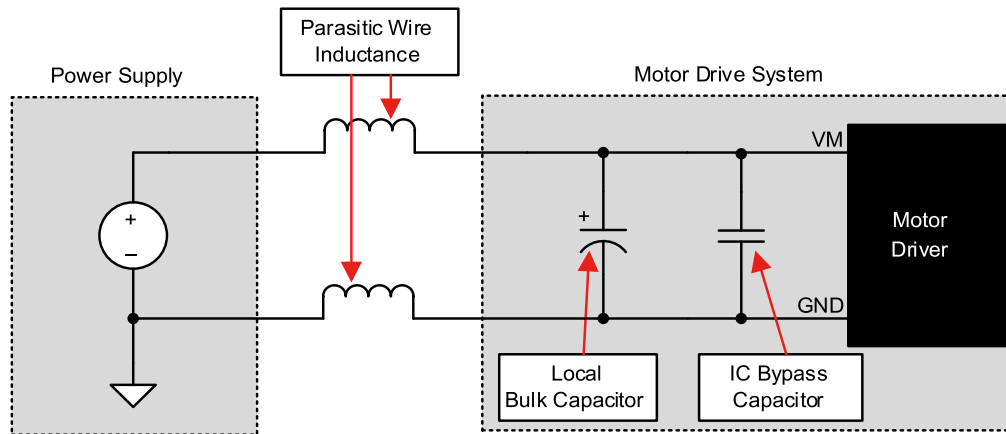


Figure 11. Example Setup of Motor Drive System With External Power Supply

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.

12 Layout

12.1 Layout Guidelines

The VM and VCC pins should be bypassed to GND using low-ESR ceramic bypass capacitors with a recommended value of 0.1μF rated for VM and VCC. These capacitors should be placed as close to the VM and VCC pins as possible with a thick trace or ground plane connection to the device GND pin.

12.2 Layout Example

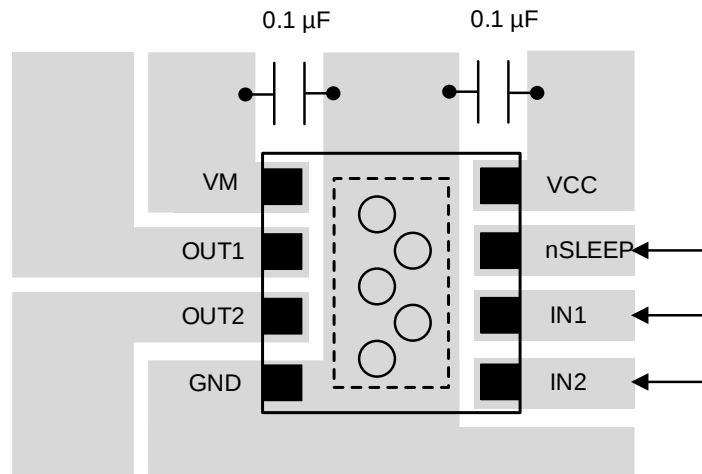


Figure 12. Simplified Layout Example

12.3 Power Dissipation

Power dissipation in the RS8837 is dominated by the power dissipated in the output FET resistance, or $R_{DS(on)}$. Use Equation 1 to estimate the average power dissipation when running a stepper motor.

$$P_{TOT} = R_{DS(on)} \times (I_{OUT(RMS)})^2 \quad (1)$$

where

- P_{TOT} is the total power dissipation
- $R_{DS(on)}$ is the resistance of the HS plus LS FETs
- $I_{OUT(RMS)}$ is the rms or dc output current being supplied to the load

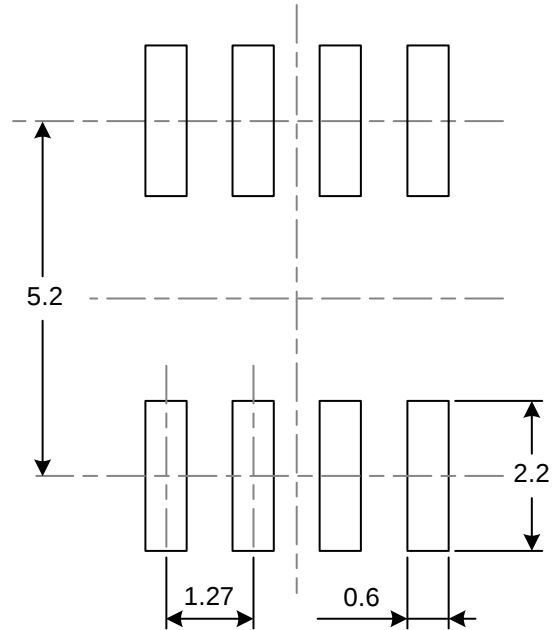
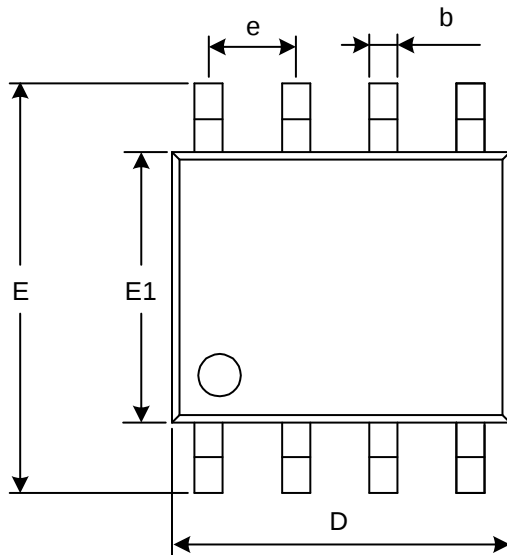
The maximum amount of power that can be dissipated in the device is dependent on ambient temperature and heatsinking.

Note: The value of $R_{DS(on)}$ increases with temperature, so as the device heats, the power dissipation increases.

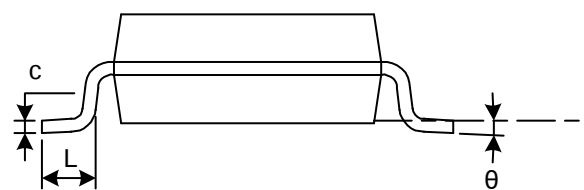
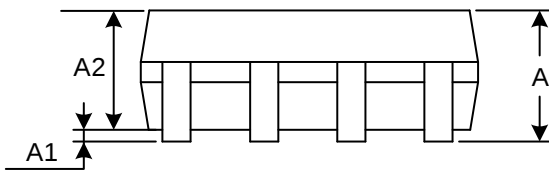
The RS8837 has thermal shutdown protection. If the die temperature exceeds approximately 160°C, the device is disabled until the temperature drops to a safe level. Any tendency of the device to enter thermal shutdown is an indication of either excessive power dissipation, insufficient heatsinking, or too high an ambient temperature.

13 PACKAGE OUTLINE DIMENSIONS

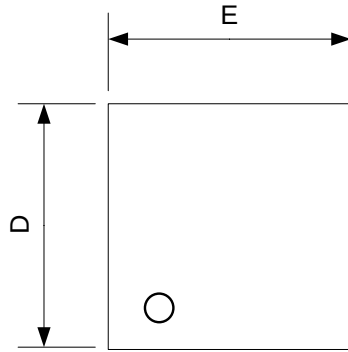
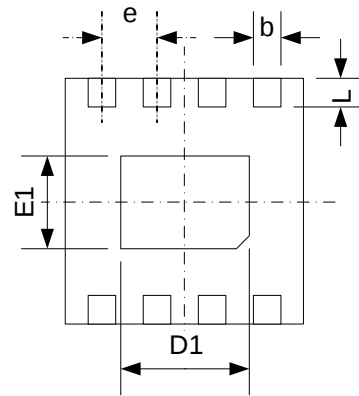
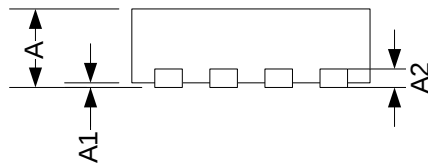
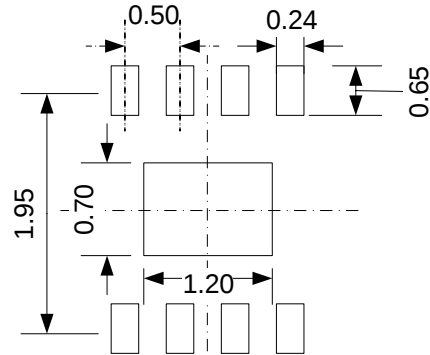
SOIC-8(SOP8)



RECOMMENDED LAND PATTERN (Unit: mm)



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.007	0.010
D	4.800	5.000	0.189	0.197
e	1.270 (BSC)		0.050 (BSC)	
E	5.800	6.200	0.228	0.244
E1	3.800	4.000	0.150	0.157
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

DFN2x2-8L

TOP VIEW

BOTTOM VIEW

SIDE VIEW

RECOMMENDED LAND PATTERN
(Unit: mm)

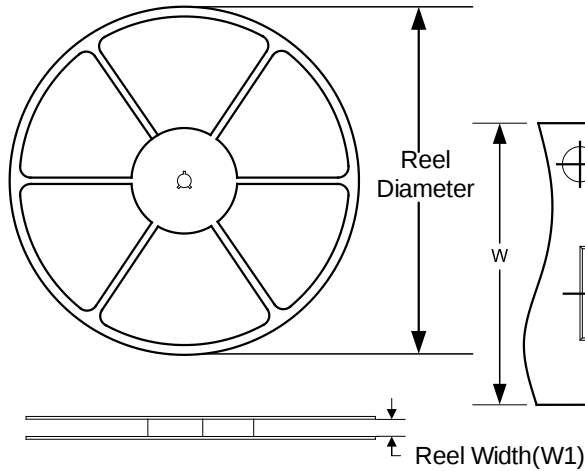
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.700	0.800	0.028	0.031
A1	0.000	0.050	0.000	0.002
A2	0.203(TYP)		0.008(TYP)	
b	0.180	0.300	0.007	0.012
D	1.900	2.100	0.075	0.083
D1	1.100	1.300	0.043	0.051
E	1.900	2.100	0.075	0.083
E1	0.600	0.800	0.024	0.031
e	0.500(TYP)		0.020(TYP)	
L	0.250	0.450	0.010	0.018

NOTE:

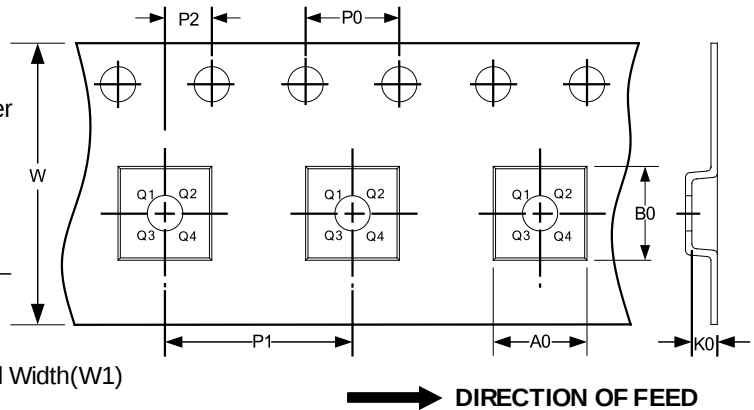
- A. All linear dimension is in millimeters.
- B. This drawing is subject to change without notice.
- C. Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.15 per side.
- D. BSC: Basic Dimension. Theoretically exact value shown without tolerances.

14 TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSION



NOTE: The picture is only for reference. Please make the object as the standard.

KEY PARAMETER LIST OF TAPE AND REEL

Package Type	Reel Diameter	Reel Width (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	P1 (mm)	P2 (mm)	W (mm)	Pin1 Quadrant
SOIC-8(SOP8)	13"	12.4	6.40	5.40	2.10	4.0	8.0	2.0	12.0	Q1
DFN2x2-8L	7"	9.5	2.30	2.30	1.10	4.0	4.0	2.0	8.0	Q2

NOTE:

1. All dimensions are nominal.
2. Plastic or metal protrusions of 0.15mm maximum per side are not included.

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