PRODUCT DESCRIPTION

The MD9927 provides an integrated motor driver solution for cameras, consumer products, toys, and other low-voltage or battery-powered motion control applications.

The device can drive one dc motor or other devices like solenoids. The output driver block consists of N-channel power MOSFETs configured as an H-bridge to drive the motor winding. An internal charge pump generates needed gate drive voltages.

The MD9927 can supply up to 1.8A of output current. It operates on a motor power supply voltage from 0 to 12 V, and a device power supply voltage of 1.8 V to 7 V.

The MD9927 device has a PWM (IN1-IN2) input interface. It is compatible with industry-standard devices.

Internal shutdown functions are provided for overcurrent protection, short-circuit protection, undervoltage lockout, and overtemperature.

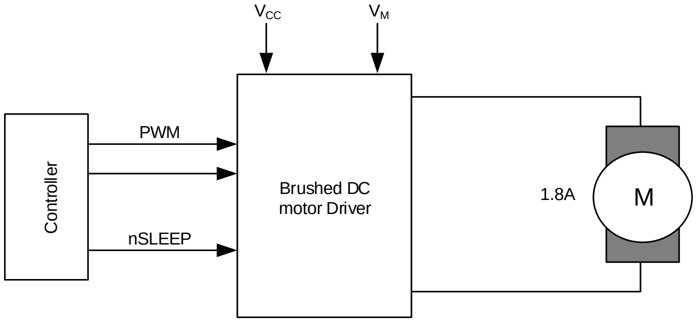
APPLICATIONS:

- Cameras
- DSLR Lenses
- Medical Device
- Robotics, Toys
- Consumer Products

FEATURES:

- H-Bridge Motor Driver
  - Drives a DC Motor or Other Loads
  - Low MOSFET On-Resistance: HS + LS 500 mΩ
- 1.8 A Maximum Drive Current
- Separate Motor and Logic Supply Pins
  - Motor VM: 0 to 12 V
  - Logic VCC: 1.8 to 7 V
- PWM Interface
  - PWM, IN1 and IN2
- Low-Power Sleep Mode With 120-nA Maximum Sleep Current
  - nSLEEP pin
- Small Package and Footprint
  - 8-Pin DFN With Thermal Pad
  - 2.0 × 2.0 mm
- Protection Features
  - VCC Undervoltage Lockout (UVLO)
  - Overcurrent Protection (OCP)
  - Thermal Shutdown (TSD)

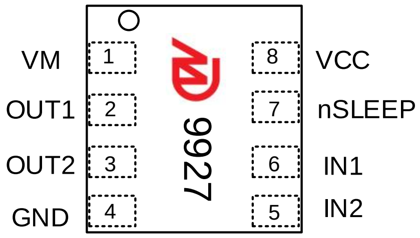
TYPICAL APPLICATION CIRCUIT:



MD9927 Simplified Diagram

■ PIN CONFIGURATION (TOP VIEW):

DFN2*2
8-Pin with Thermal Pad



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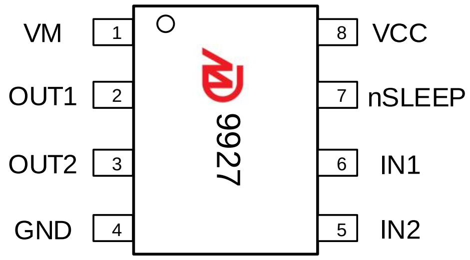


■ PIN DESCRIPTION:

NAME	SOIC-8	DESCRIPTION
VM	1	Motor power supply Bypass this pin to the GND pin with a 0.1 μF ceramic capacitor rated for VM.
OUT1	2	Motor output Connect these pins to the motor winding.
OUT2	3	
GND	4	Device ground This pin must be connected to ground.
IN2	5	IN2 input See the Detailed Description section for more information.
IN1	6	IN1 input See the Detailed Description section for more information.
nSLEEP	7	Sleep mode input When this pin is in logic low, the device enters low-power sleep mode. The device operates normally when this pin is logic high. Internal pulldown
VCC	8	Connect to Logic power supply Bypass this pin to the GND pin with a 0.1 μF ceramic capacitor rated for VCC.

■ Absolute Maximum Ratings:

(Unless otherwise indicated: T_a=25℃)

PARAMETER	SYMBOL	RATINGS	UNIT
Motor power-supply voltage	VM	-0.3 ~ 18	V
Logic power-supply voltage	VCC	-0.3 ~ 7	
Control pin voltage	IN1, IN2, nSLEEP	-0.3 ~ 7	
Peak drive current	OUT1, OUT2	Internally limited	A
Human body model (HBM)	$V_{(ESD)}$	±4000	V
Operating virtual junction temperature, T_J		-40 ~ 150	℃
Storage temperature, T_{stg}		-60 ~ 150	

Note: Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device

■ Recommended Operating Conditions

(Unless otherwise indicated: T_a=25℃)

PARAMETER	SYMBOL	RATINGS	UNIT
Motor power-supply voltage	VM	0 ~ 12	V
Logic power-supply voltage	VCC	1.8 ~ 7	
Logic level input voltage	V_{LOGIC}	0 ~ 5.5	
Motor peak current	I_{OUT}	0 ~ 1.8	A
Externally applied PWM frequency	f_{PWM}	0 ~ 250	kHZ
Operating ambient temperature	T_A	-40 ~ 85	℃

ELECTRICAL CHARACTERISTICS:

T_A = 25°C, over recommended operating conditions unless otherwise noted.

PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNIT
POWER SUPPLIES (VM, VCC)						
VM operating voltage	VM		0		12	V
VM operating supply current	I_{VM}	VM = 5 V; VCC = 3 V; No PWM		30	100	μA
		VM = 5 V; VCC = 3 V; 50 kHz PWM		0.45	1.5	mA
VM sleep mode supply current	I_{VMQ}	VM = 5 V; VCC = 3 V; nSLEEP = 0		30	90	nA
VCC operating voltage	VCC		1.8		7	V
VCC operating supply current	I_{VCC}	VM = 5 V; VCC = 3 V; No PWM		0.23	0.5	mA
		VM = 5 V; VCC = 3 V; 50 kHz PWM		0.45	1.5	mA
VCC sleep mode supply current	I_{VCCQ}	VM = 5 V; VCC = 3 V; nSLEEP = 0		15	30	nA
CONTROL INPUTS (IN1, IN2, nSLEEP)						
Input logic-low voltage falling threshold	V_{IL}		0.25 × VCC	0.38 × VCC		V
Input logic-high voltage rising threshold	V_{IH}			0.46 × VCC	0.5 × VCC	
Input logic hysteresis	V_{HYS}			0.08 × VCC		
Input logic low current	I_{IL}	V_{IN} = 0 V	-5		5	μA
Input logic high current	I_{IH}	V_{IN} = 3.3 V, IN1 or IN2 pin		60		
		V_{IN} = 3.3 V, nSLEEP pin		50		
Pulldown resistance	R_{PD}			100		kΩ
MOTOR DRIVER OUTPUTS (OUT1, OUT2)						
HS + LS FET on-resistance		VM = 5 V; VCC = 3 V; I_O = 800 mA; T_J = 25°C		500		mΩ
Off-state leakage current		V_{OUT} = 0 V	-200		200	nA
PROTECTION CIRCUITS						
VCC undervoltage lockout	V_{UVLO}	VCC falling			1.7	V
		VCC rising			1.8	
Overcurrent protection trip level	I_{OCP}		1.9		3.5	A
Overcurrent deglitch time	t_{DEG}			1		μs
Overcurrent deglitch time	T_{RETRY}			1		ms
Thermal shutdown temperature	t_{TSD}	Die temperature T_J		170		℃

■ Timing Requirements

PARAMETER	SYMBOL	MIN.	MAX.	UNIT
Output enable time	t_1		300	ns
Output disable time	t_2		300	ns
Delay time, INx high to OUTx high	t_3		160	ns
Delay time, INx low to OUTx low	t_4		160	ns
Output rise time	t_5	30	188	ns
Output fall time	t_6	30	188	ns

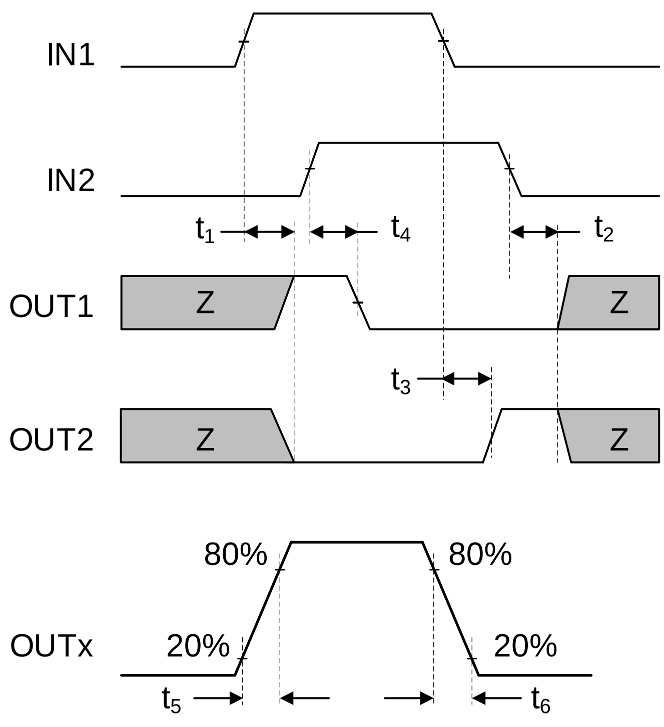


Figure 1. Input and Output Timing for MD9927

■ TYPICAL PERFORMANCE CHARACTERISTICS(CONTINUTED):

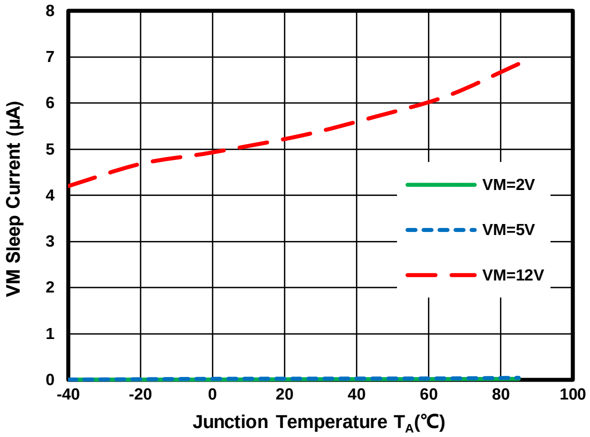


Figure 2. I_{VMQ} vs T_A

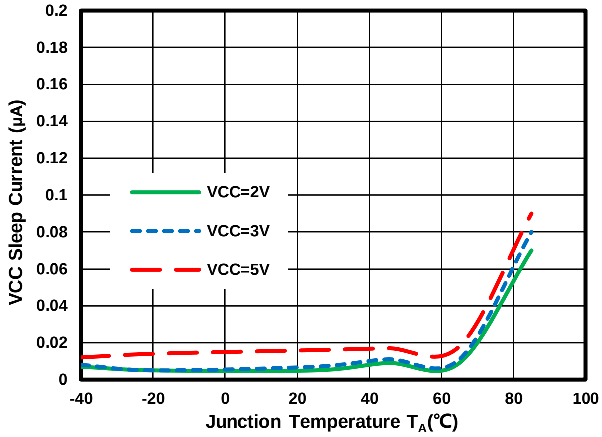


Figure 3. I_{VCCQ} vs T_A

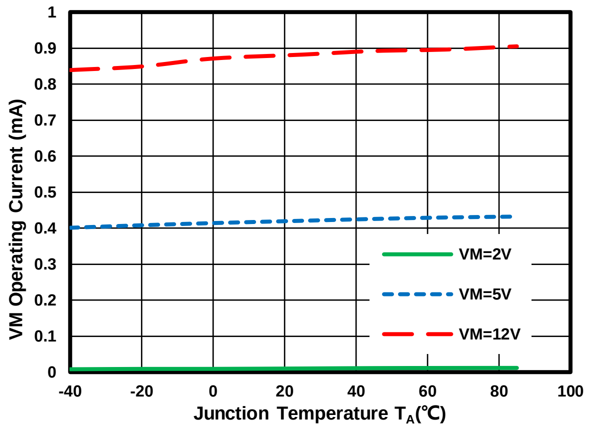


Figure 4. I_{VM} vs T_A (50-kHz PWM)

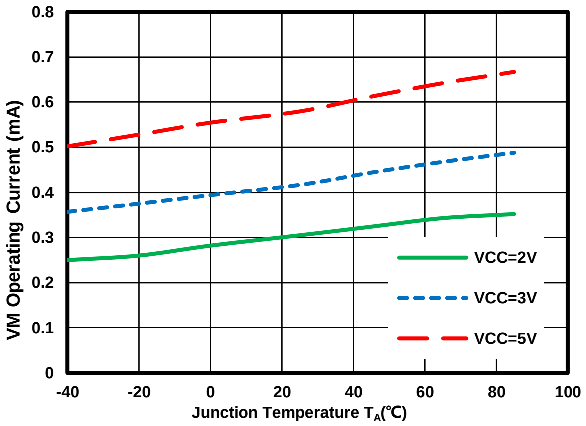


Figure 5. I_{VCC} vs T_A (50-kHz PWM)

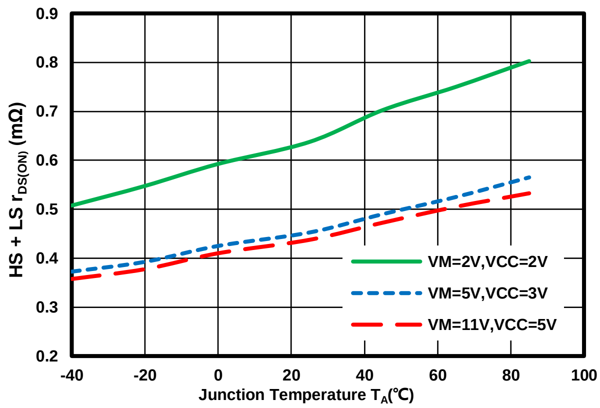


Figure 6. HS + LS $r_{DS\ (ON)}$ vs T_A

■ Functional Block Diagram

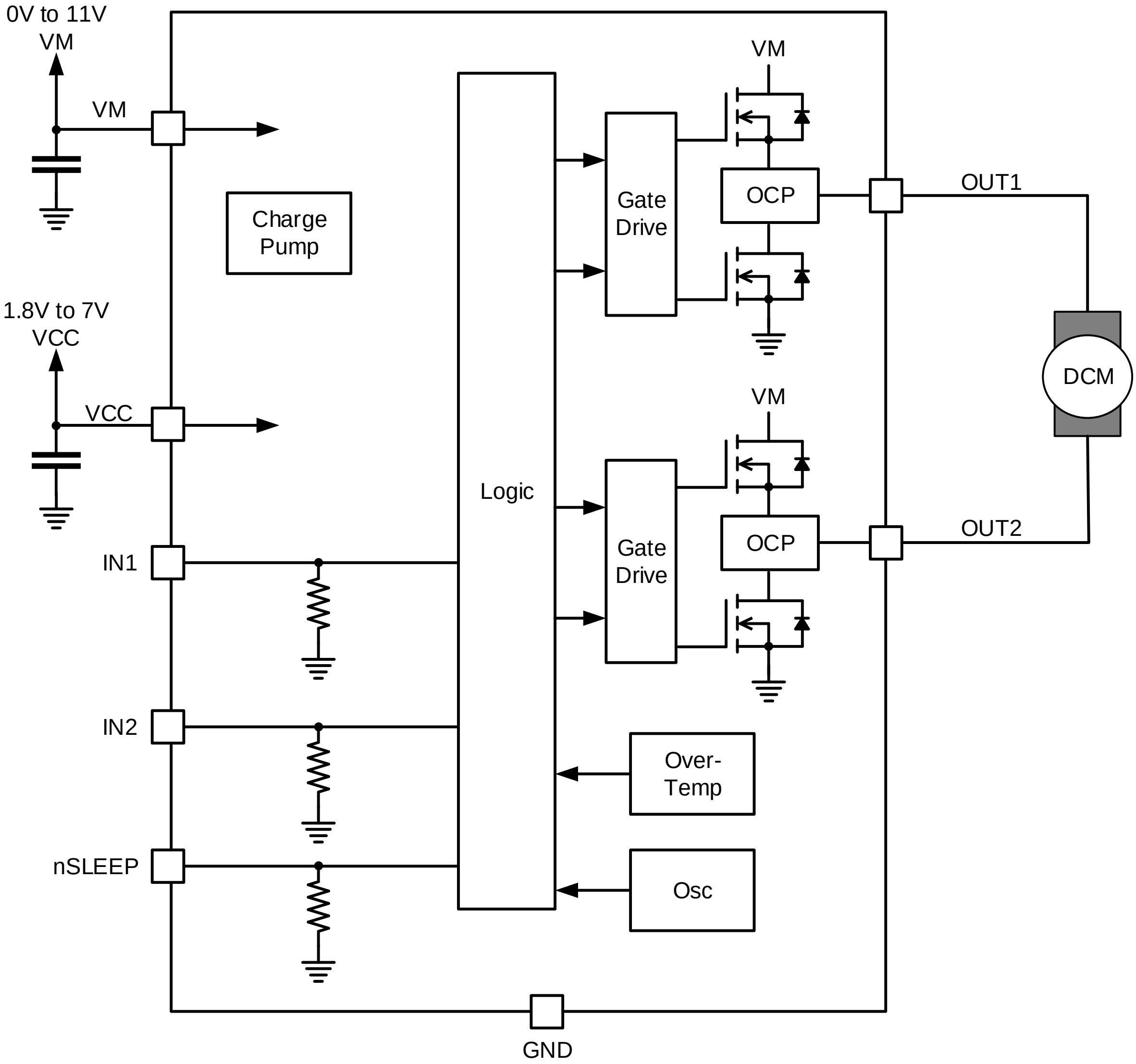


Figure 7. MD9927 Functional Block Diagram

■ Detailed Description

1) Overview

The MD9927 devices 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) on the MD9927 device. 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 MD9927 devices adds protection features beyond traditional discrete implementations: undervoltage lockout, overcurrent protection, and thermal shutdown.

1) Bridge Control

The MD9927 device is controlled using a PWM input interface, also called an IN-IN interface. Each output is controlled by a corresponding input pin.

The Table 1 shows the logic for the MD9927 device.

Table 1.MD9927 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

2) Sleep Mode

If the nSLEEP pin is brought to a logic-low state, the MD9927 devices enters a low-power sleep mode. In this state, all unnecessary internal circuitry is powered down.

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 if the supply voltage is between 1.8 and 7 V.

The VM voltage supply does not have any undervoltage-lockout protection (UVLO) so if VCC > 1.8 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.

4) Protection Circuits

The MD9927 devices is fully protected against VCC undervoltage, overcurrent, and overtemperature events.

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.

6) Overcurrent Protection (OCP)

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.

7) Thermal Shutdown (TSD)

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 (UVLO)	VCC < 1.7 V	Disabled	VCC > 1.8 V
Overcurrent (OCP)	I_{OUT} > 1.9 A (MIN)	Disabled	t_{RETRY} elapses
Thermal Shutdown (TSD)	T_J > 150°C (MIN)	Disabled	T_J < 150°C

■ Application and Implementation

1) Application Information

The MD9927 is used to drive one dc motor or other devices like solenoids. The following design procedure can be used to configure the MD9927.

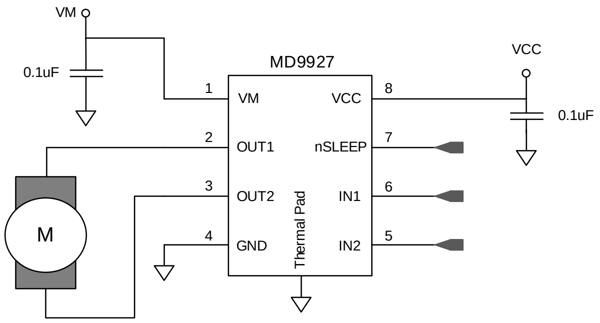


Figure 8. Typical Application of MD9927

2) Power Supply Recommendations

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 disadvantage 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.

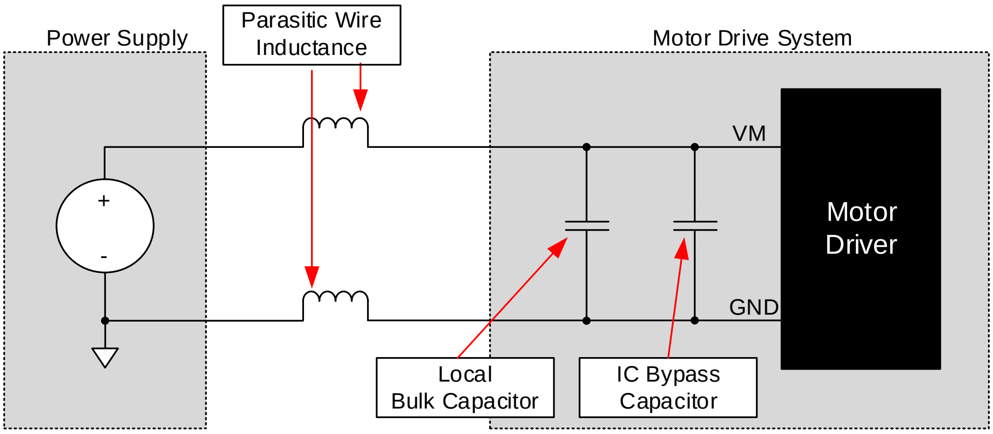


Figure 8. Example Setup of Motor Drive System With External Power Supply

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

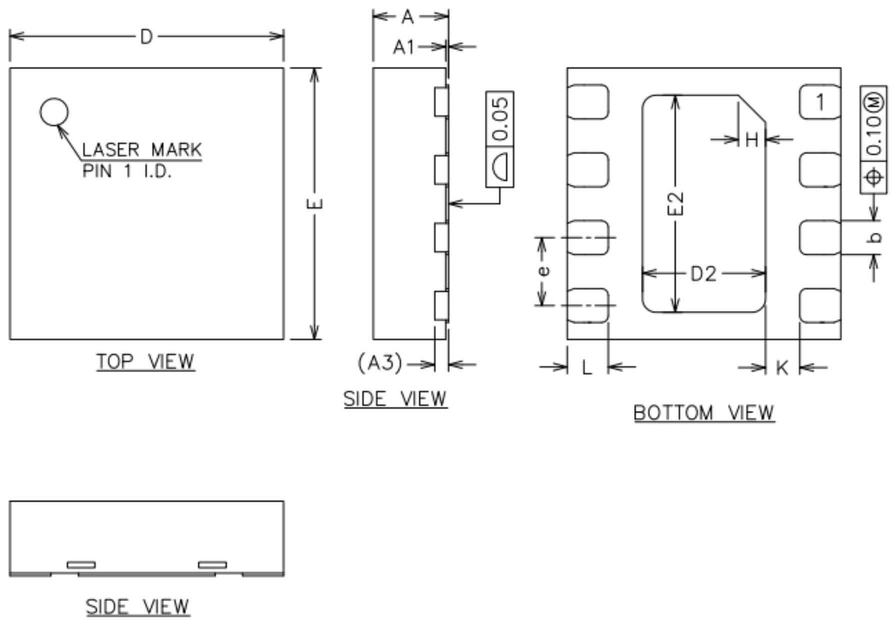
3) Detailed Design Procedure

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.

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

PACKAGING INFORMATION:

DFN8 PACKAGE OUTLINE DIMENSIONS

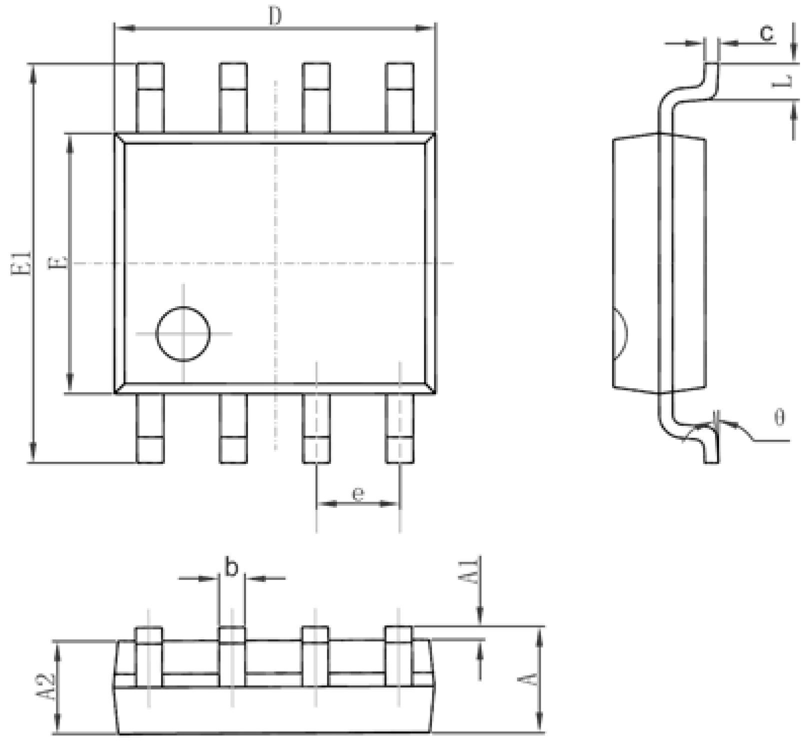


COMMON DIMENSIONS
(UNITS OF MEASURE=MILLIMETER)

SYMBOL	MIN	NOM	MAX
A	0.50	0.55	0.65
A1	0.00	0.02	0.05
A3	0.10REF		
b	0.20	0.25	0.30
D	1.90	2.00	2.10
E	1.90	2.00	2.10
D2	0.80	0.90	1.00
E2	1.50	1.60	1.70
e	0.40	0.50	0.60
H	0.20REF		
K	0.15	0.25	0.35
L	0.25	0.30	0.35

PACKAGING INFORMATION (Continued):

SOP8 PACKAGE OUTLINE DIMENSIONS



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	0.006	0.010
D	4.700	5.100	0.185	0.200
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.270 (BSC)		0.050 (BSC)	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

For the newest datasheet, please see the website: www.md-ic.com.cn

Version V1.1: 20200728