Motor Driver, 5V-40V, 0.7Ω Current Limit 4A

1 Description

The AL869 is an H-bridge motor driver for driving reversible motors that can drive a DC motor, a stepper motor winding or other loads.

The AL869 operates from a motor supply voltage of 5V to 40V, It has a overcurrent protection of 4A.

The AL869 is controlled by two input pins. The two on/off inputs determine the output mode: forward, reverse, coast or brake. When both inputs are low, very low standby circuit currents can be achieved.

The AL869 is available in SOP-8 package.

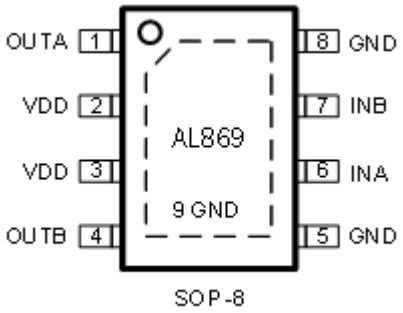
2 Features

- Wide power range: 5V to 40V
- 4A overcurrent protection
- Low MOSFET on-resistance: Rhs = 0.45Ω, Rls = 0.25Ω
- Forward, reverse, coast or brake output modes
- Suitable for a wide range of MCU control logic
- Input logic hysteresis
- Thermal shutdown

3 Applications

- Smart Circuit Breaker
- Smart Lock
- Smart meter

4 Pinout



SOP-8

5 Ordering information

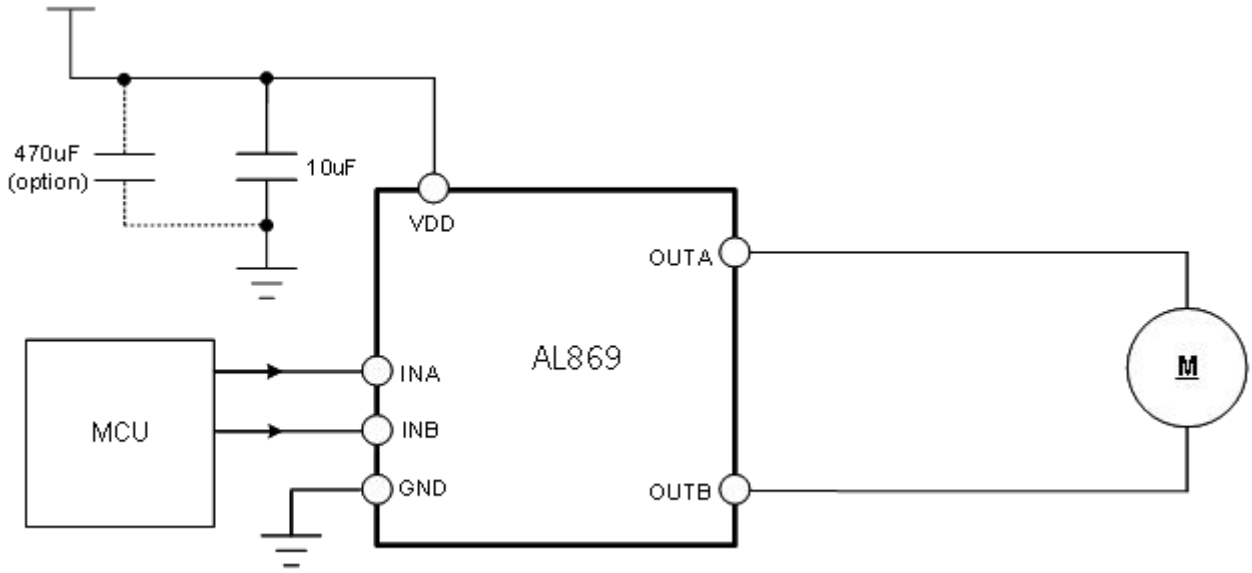
Product Number	Package	Quantity/Tape
AL869	SOP-8	4000/Tape

6 Marking

Product Number	Marking
AL869	AL869 YYWW

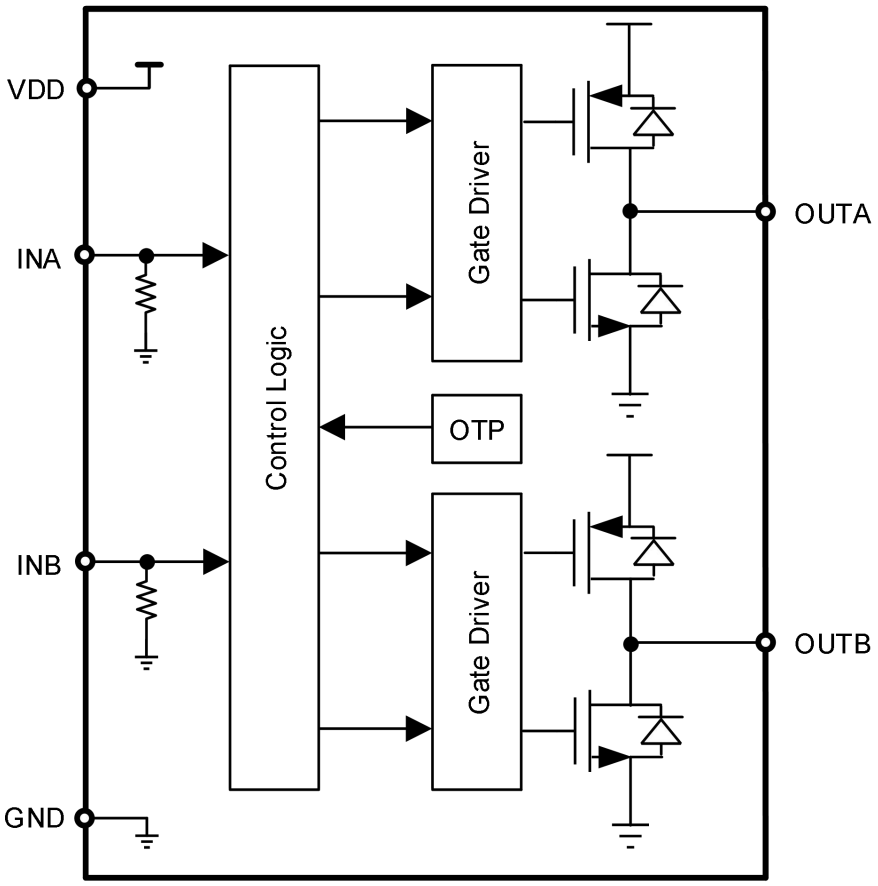
Note: YY=Year WW=Week.

7 Typical Application



Note: When the supply voltage VDD is greater than 20V, it is necessary to add a 470 uF electrolytic capacitor at the input to prevent the chip from being damaged by high voltage burrs.

8 Block Diagram



9 Pin Descriptions

AL869	Pin Name	Descriptions
1	OUTA	output, connect this pin to the motor winding.
2、3	VDD	Supply Voltage. A capacitor is required to prevent large voltage spikes.
4	OUTB	Output, connect this pin to the motor winding.
5、8	GND	Hot PAD is also GND.
6	INA	Logic input with a large internal pull-down resistor.
7	INB	Logic input with a large internal pull-down resistor.
/	NC	Recommended to be connected to GND.

10 Specifications

10.1 Absolute Maximum Ratings

Parameter	Symbol	Value	Units
VDD Supply Voltage Range	VDD	-0.5 ~ +42	V
Output Pin Voltage Range	V_{OUTA}、V_{OUTB}	-0.5 ~ +42	V
Input Pin Voltage Range	V_{INA}、V_{INB}	-0.4 ~ 6	V
Storage Temperature Range	T_{STG}	-55~150	°C
Welding Temperature	T_{LEAD}	260（soldering，10s）	°C

10.2 ESD Ratings

Discharge mode	Value	Value	Units
HBM	JEDECJS-001-2023	±5000	V
CDM	JEDECJS-002-2022	±2000	V
Latch up	JESD78F.02-2023	800	mA

10.3 Recommended Operating Range

Parameter	Symbol	Min.	Max.	Units
VDD Voltage Range	VDD	5	40	V
Input Capacitor	CIN	10		uF
Operating Temperature	T_A	-40	105	°C

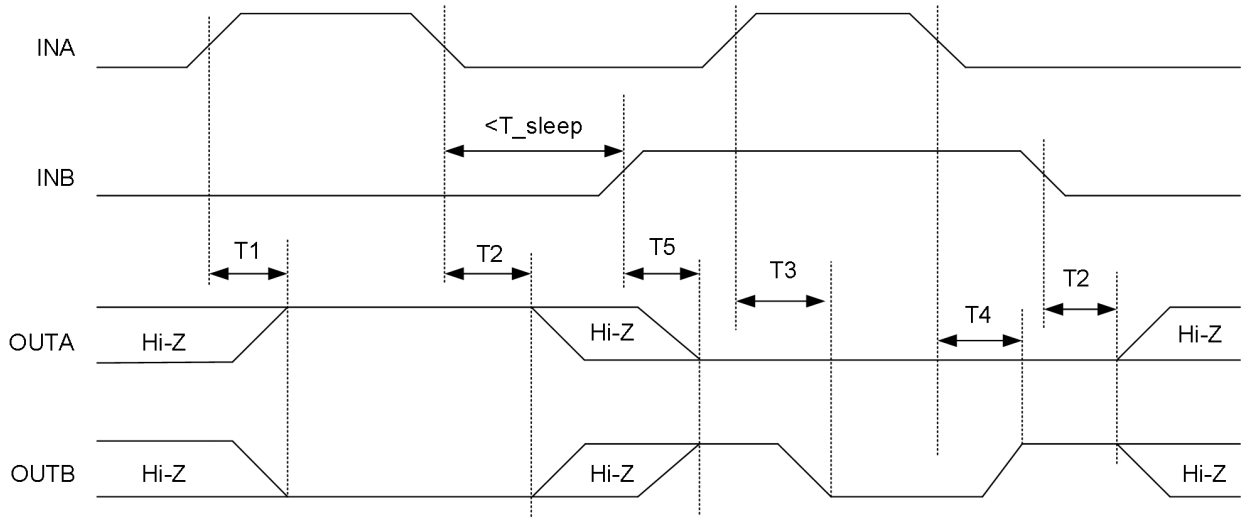
10.4 Thermal Information

Parameter	Package	Value	Unit
θ_{JA}	SOP-8	160	°C/W

10.5 Electrical Characteristics

Test conditions: TA = 25°C, VDD = 12V, unless otherwise specified.

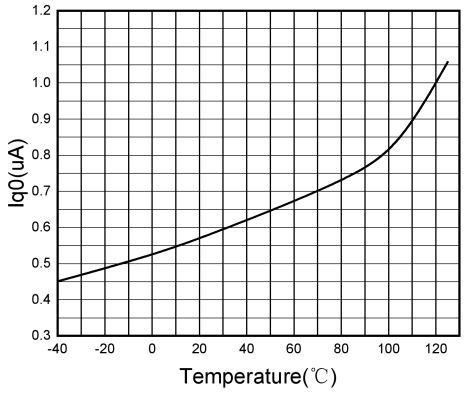
Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Standby Mode Supply Current	Iq0	INA=INB=0V		0.6		μA
Operating Supply Current	Iq1			200		μA
UVLO Threshold				4	4.4	V
UVLO Hysteresis				0.15		V
Input High Voltage	VIH		1.2			V
Input Low Voltage	VIL				0.4	V
Input Current	IIH	VIN=3.3V		3.5		μA
Input Pull Down Resistor	RIN			1.2		MΩ
HS turn-on resistor	Rhs	ILOAD=300mA		0.45	0.6	Ω
LS turn-on resistor	Rls	ILOAD=300mA		0.25	0.4	Ω
Current Limit Protection			3	4		A
Output Enable Time	T1	VDD > VUVLO with INA or INB high		10		us
Delay Time	T2	INA and INB low to OUT Hi-Z delay time		200		ns
	T3	INx high to OUTx low delay time		200		ns
	T4	INx low to OUTx high delay time		300		ns
	T5	INA or INB high to OUT quit Hi-Z delay time		200		ns
Dead time	Tdead			200		ns
Time to enter sleep mode	T_sleep	Inputs low to sleep		1.1		ms
Thermal shutdown threshold	OTP			155		°C
OCP deglitch time	Tdeg			1.8		μs



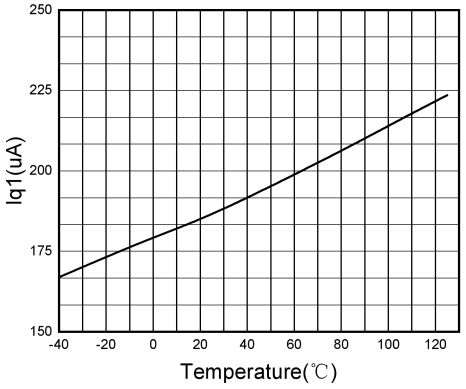
10.6 Characteristics Curve

Test conditions: TA = 25°C, VDD = 12V, unless otherwise specified.

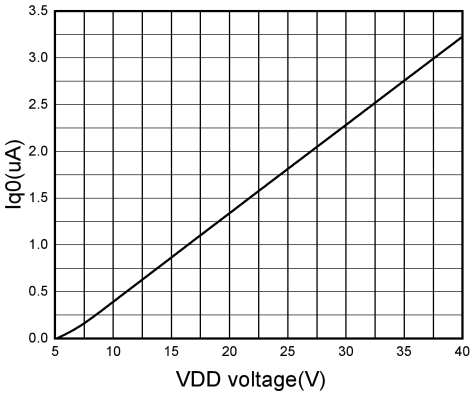
Iq0 vs Temperature



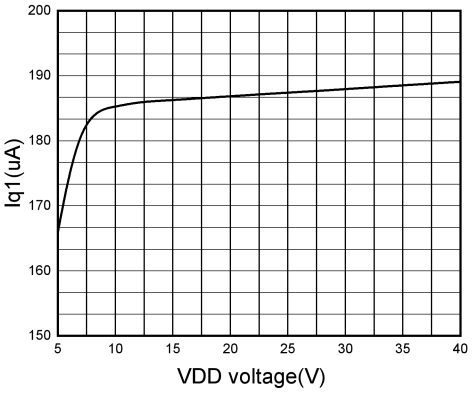
Iq1 vs Temperature



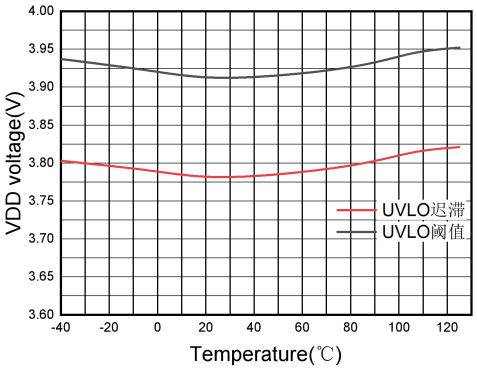
Iq0 vs VDD voltage



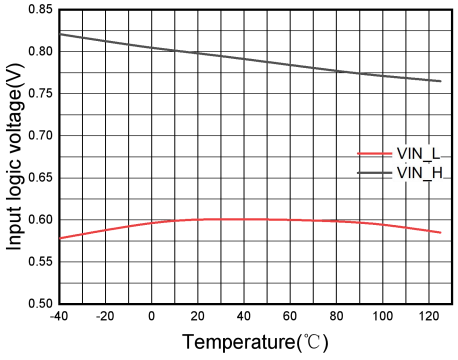
Iq1 vs VDD voltage

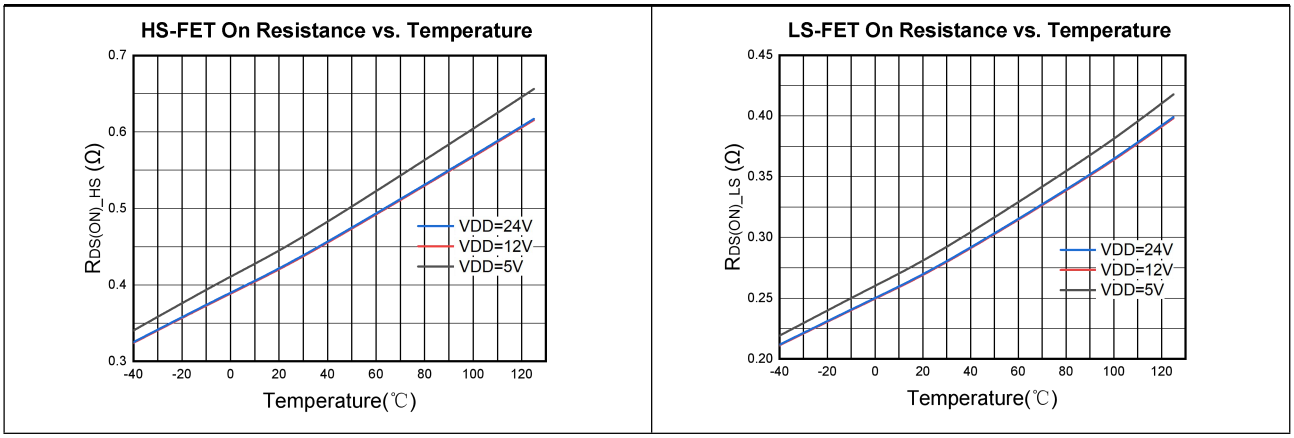


VDD UVLO vs Temperature



Input logic Voltage vs Temperature





11 Detailed Description

11.1 Overview

The AL869 is an H-bridge driver that can drive a DC motor or other devices such as solenoid valves. The output can be controlled by the PWM interfaces (INA and INB) of the AL869. These devices integrate the necessary driver FETs and FET control circuits, thereby greatly reducing the number of components in a motor driver system. In addition, the AL869 adds protection features that go beyond conventional discrete implementations: overcurrent protection and thermal shutdown.

11.2 Speed Regulation

PWM (Pulse Width Modulation) technology achieves precise control of motor speed by adjusting the duty cycle of the pulse signal. This technique regulates the average value of the input voltage to the motor by changing the duty cycle of the PWM signal, i.e. the ratio of the pulse width to the pulse period, which in turn controls the motor speed. Specifically, the larger the duty cycle of the PWM signal, the higher the average value of the motor input voltage and the faster the motor speed; conversely, the smaller the duty cycle, the slower the motor speed.

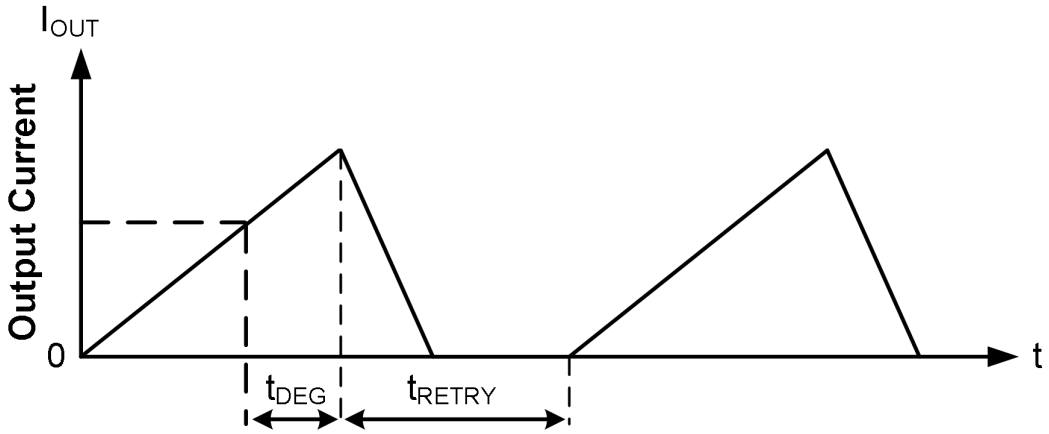
11.3 Motor Control

The AL869 is controlled via PWM input interfaces (INA and INB interfaces). Each output is controlled by the corresponding input pin.

INA	INB	OUTA	OUTB	Functions (DC motors)
L	L	Hi-Z	Hi-Z	Coast
L	H	L	H	Reverse
H	L	H	L	Forward
H	H	L	L	Brake

11.4 Overcurrent Protection

Each FET is equipped with an analog current-limiting circuit that restricts the current flowing through the FET by eliminating the gate drive. If the analog current limit persists for longer than tDEG, all FET in the H-bridge will be disabled. Operation will automatically resume after tRETRY. Both the high-side and low-side FETs can detect overcurrent conditions. Shorting or grounding the OUTA pin to the OUTB pin will result in overcurrent.

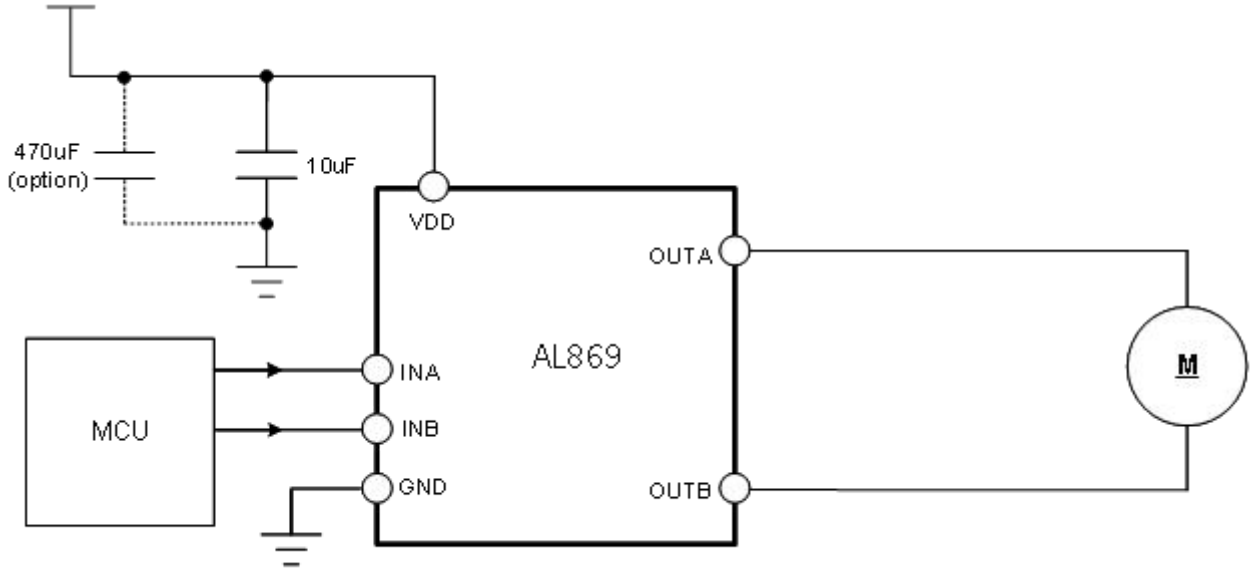


11.5 Thermal Shutdown

If the chip temperature exceeds 155°C, all FET in the H-bridge are disabled. Operation is automatically resumed when the chip temperature drops below 125°C.

12 Application information

12.1 Typical applications



12.2 Design requirements

Design parameters	Symbol	Value
Motor Supply Voltage	VDD	12V
Logic High	IN	3.3V
Motor Current RMS	IOUT	1A

12.3 Design process

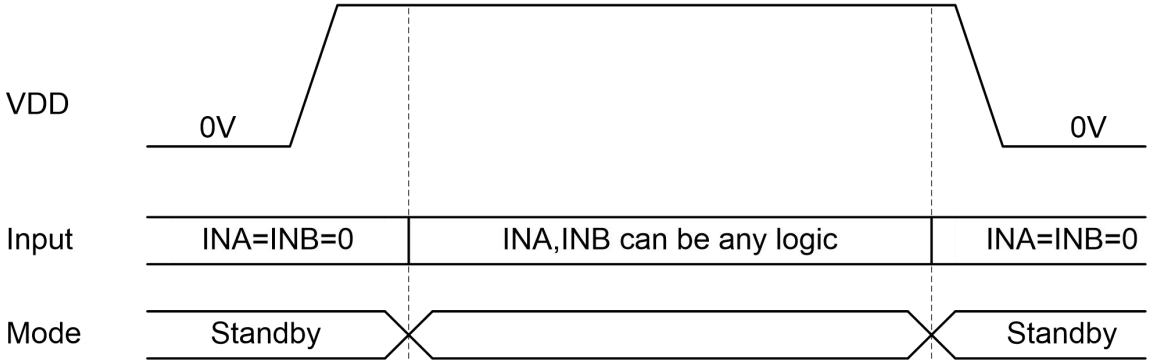
12.3.1 Motor Voltage

The proper motor voltage depends on the rating of the selected motor and the desired speed. With the same PWM duty cycle of the power FET, the higher the voltage, the faster the brushed DC motor speed.

Higher voltages also increase the rate of change of current through the inductive motor windings.

12.3.2 VDD Power-Up

Make sure that the input signals INA and INB pins remain low during VDD power-up and power-down.



12.3.3 Low power operation

When INA and INB become low for more than 1.1ms, enter sleep mode to minimize system power consumption.

12.3.4 Input Capacitance

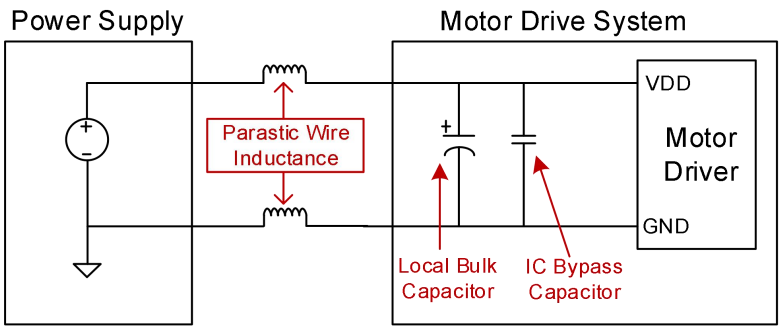
Proper input capacitance is an important factor in the design of a motor drive system. In general, the larger the capacitance, the better, with the disadvantage of increased cost and physical size.

The size of the required input capacitance depends on a number of factors including.

- Maximum current required by the motor system.
- Power supply capacitance and current source capability.
- Parasitic inductance between the power supply and motor system.
- Acceptable voltage ripple.
- Type of motor used (brushed DC motor, brushless DC motor, stepper motor).
- Method of motor braking.

The inductance between the power supply and the motor drive system limits the rate of change of the power supply current. If the input capacitor capacity is too small, the system responds to excessive current demand or motor dumps with voltage changes. If a large enough input capacitor is used, the motor voltage will remain stable and large currents will be available quickly.

Datasheets usually provide recommended values, but system-level testing is required to determine the proper capacitance.



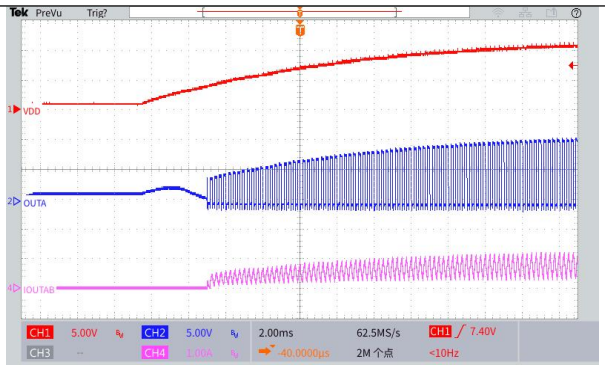
12.4 PCB Layout Guidelines

12.4.1 PCB Layout Recommendations

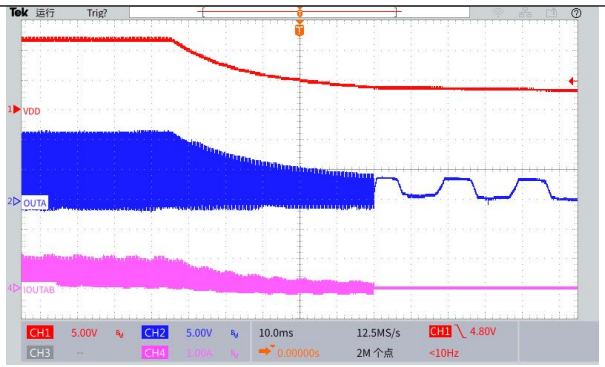
- It is recommended that low ESR ceramic capacitors be used to connect the VDD pin to GND, with a recommended rating of 10 μF. These capacitors should be placed as close as possible to the VDD pin, and the alignment should be as coarse as possible to connect to the ground plane.

12.5 Operating waveforms

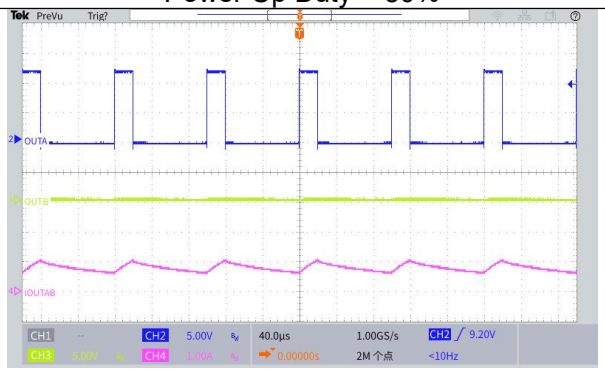
Test conditions: TA = 25°C, VDD = 12V, unless otherwise specified.



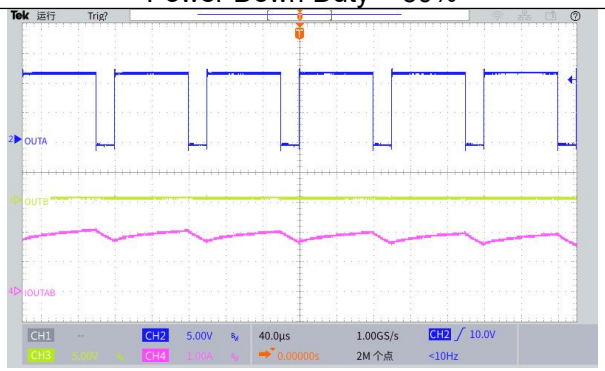
Power Up Duty = 50%



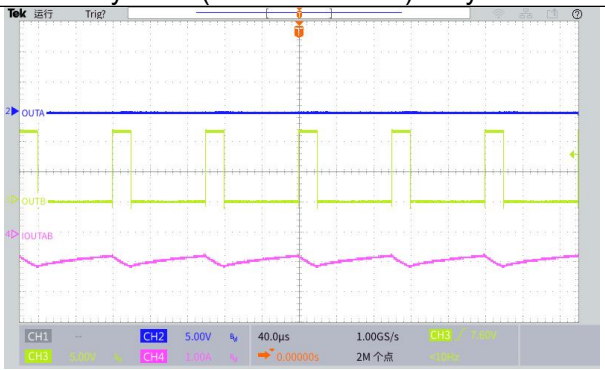
Power Down Duty = 50%



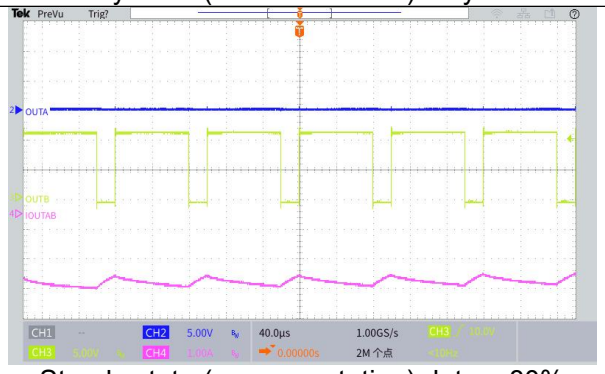
Steady state (forward rotation) Duty = 20%



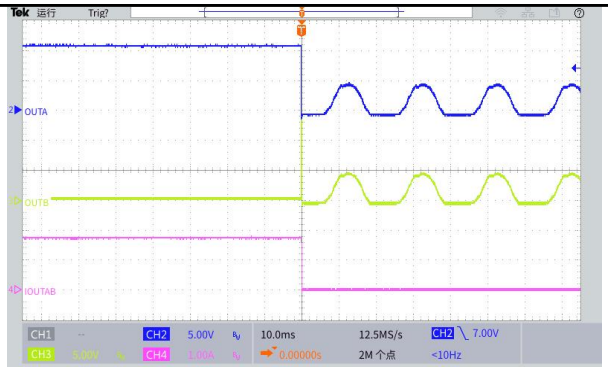
Steady state (forward rotation) duty = 80%



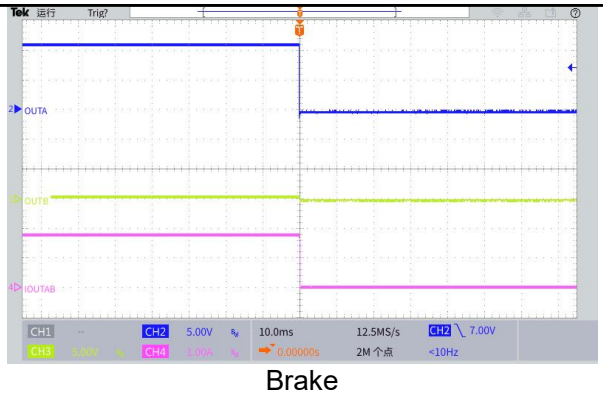
Steady state (reverse rotation) duty = 20%



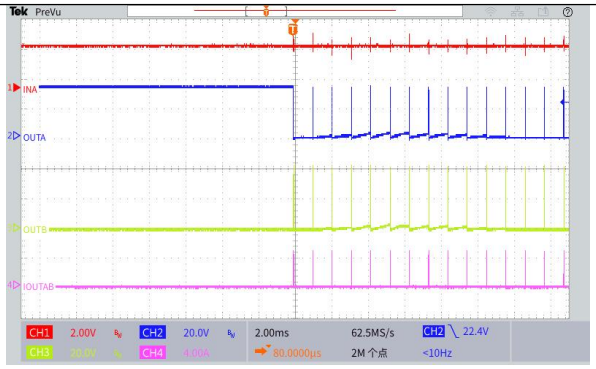
Steady state (reverse rotation) duty = 80%



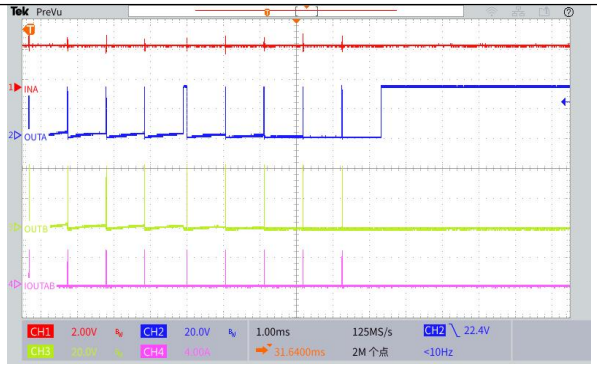
Coast



Brake



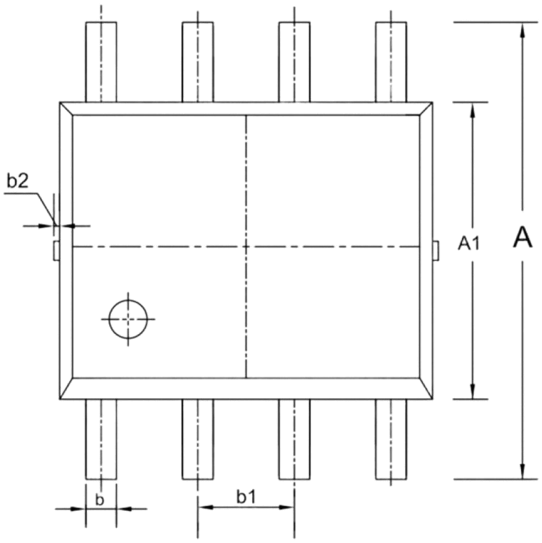
OCP

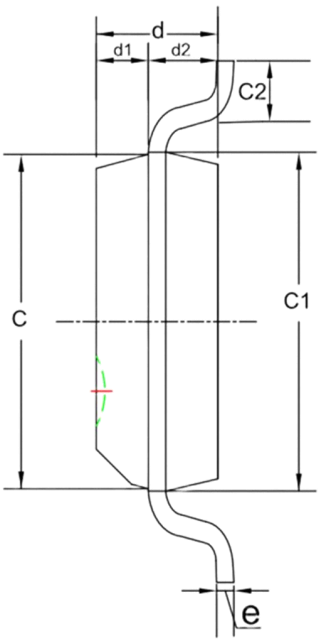


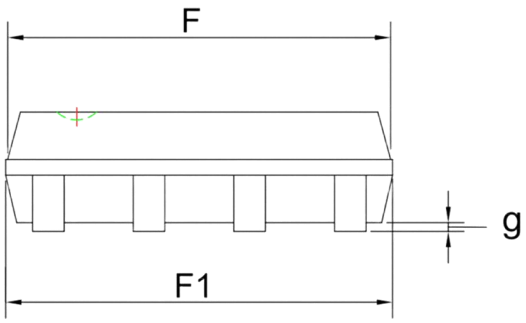
OCP Recovery

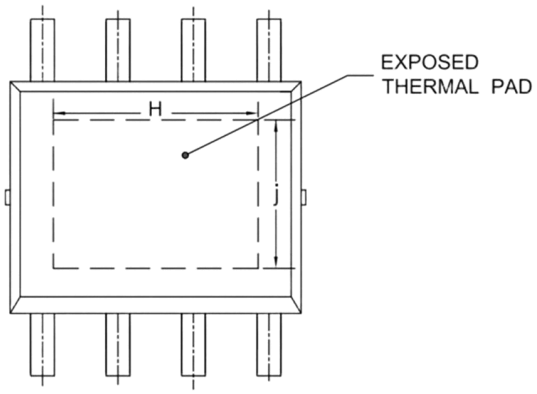
13 Package Information

SOP-8









Dimension / Symbol	MIN （mm）	MAX (mm)
A	5.85	6.15
A1	3.8	4.0
b	0.39	0.41
b1	1.26	1.28
b2	0	0.08
C	3.75	3.95
C1	3.8	4.0
C2	0.5	0.7

Dimension / Symbol	MIN （mm）	MAX (mm)
d1	0.55	0.65
d2	0.75	0.85
e	0.249	0.259
F	4.75	4.95
F1	4.8	5.0
g	0.06	0.16
H	3.172	3.448
j	2.283	2.496