Dual-channel brushed DC motor drive circuit

MX1616H

characteristic

ÿ Low standby current (less than 0.1uA)

ÿ Low on-resistance MOSFET power switch tube

— Using MOS technology to design power tube

— 1 channel 1.6A power tube internal resistance 0.4 ohm

— 2 channels 1.6A power tube internal resistance 0.4 ohm

ÿ Smaller input current

— Integrated about 15K pull-down resistor

— 3V drive signal average 200uA input current

ÿ Built-in thermal protection circuit (TSD) with hysteresis effect

ÿ Antistatic grade: 4KV (HBM)

Application

ÿ 2-4 AA/AAA dry cell powered toy motor driver

ÿ Toy motor drive powered by 2-5 NiMH/NiCd rechargeable batteries move

ÿ Motor drive powered by 1-2 lithium batteries

Overview

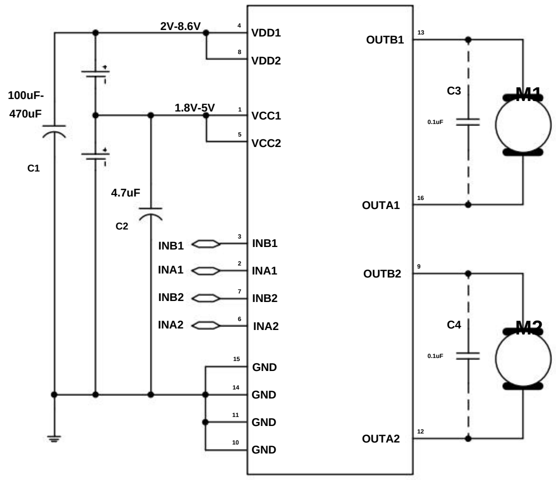
This product adopts H-bridge circuit structure design and adopts high reliability The power tube technology is particularly suitable for driving inductive loads such as coils and motors. The circuit integrates N-channel and P-channel power MOSFETs. The voltage range covers 2V to 8.6V. 27ÿ, VDD=6.5V, two Under the condition that the channels work simultaneously, the maximum continuous output current of 1 channel is Up to 1.3A, the maximum peak output current reaches 3A; 2 channels maximum The continuous output current reaches 1.3A and the maximum peak output current reaches 3A.

This circuit is a power device, which has a certain internal resistance. The heat generation is related to the load current, the internal resistance of the power tube and the ambient temperature. The circuit design has a chip-level temperature detection circuit, which can detect the temperature in real time. Monitor the internal heat of the chip. When the internal temperature of the chip exceeds the set value, Generate a power tube shutdown signal to turn off the load current to avoid abnormal The temperature continues to rise due to use, causing the plastic package to smoke, Fire and other serious safety accidents. The temperature hysteresis circuit built into the chip, After ensuring that the circuit has returned to a safe temperature, the power tube can be reconnected. Take control.

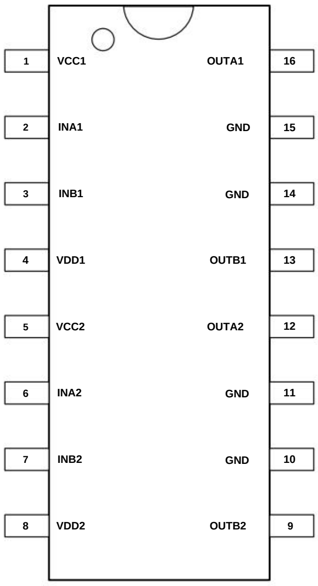
Ordering Information

Product Model	Encapsulation	Operating temperature
MX1616H	SOP16	-20ÿ ~ 85ÿ

Typical application diagram



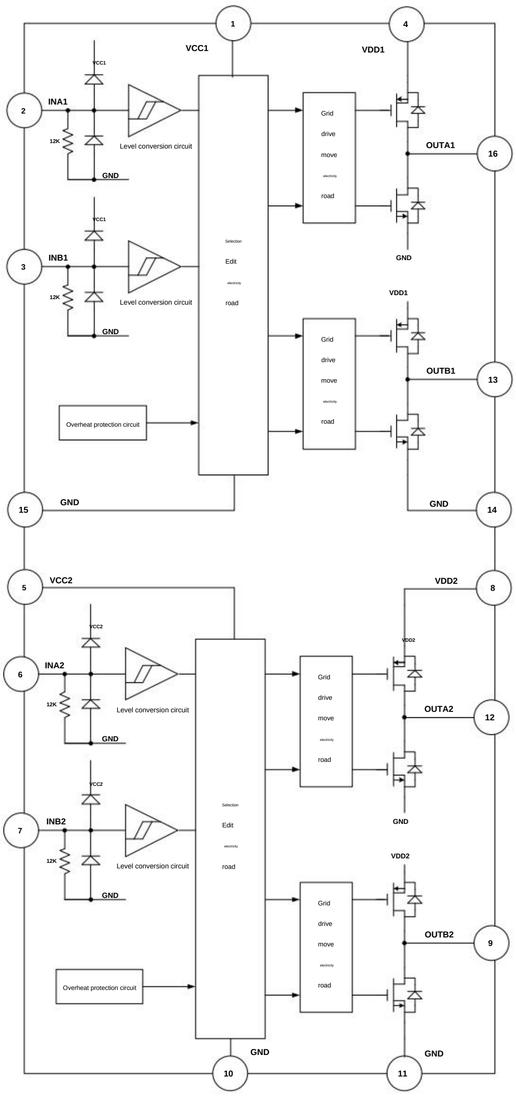
Pinout



Pin Definition

Pin No.	Pin Name	Input/Output	Pin Function Description
1	VCC1		1 channel logic control power supply terminal
2	INA1		1 channel forward logic input
3	INB1		1 channel inverting logic input
4	VDD1		1 channel power supply terminal
5	VCC2		2-channel logic control power supply terminal
6	INA2		2-channel forward logic input
7	INB2		2-channel logic input
8	VDD2		2-channel power supply terminal
9	OUTB2	O	2-channel inverted output
10	GND	- Ground	
11	GND	- Ground end	
12	OUTA2	O	2-channel forward output
13	OUTB1	O 1 channel	inverted output
14	GND	- Ground	
15	GND	- Ground end	
16	OUTA1	THE	1 channel forward output

Functional Block Diagram

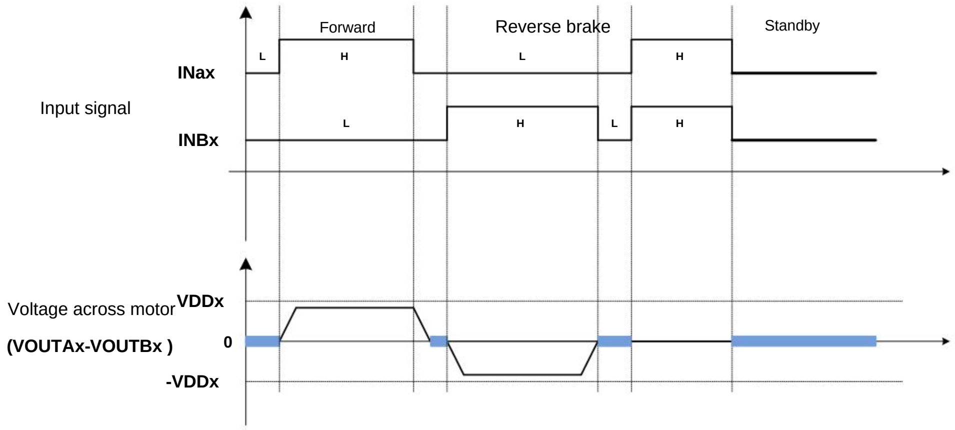


Logic truth table

INax	INBx	OUTAx	OUTBx	Function
L	L	WITH	WITH	Standby
H	L	H	L	Forward
L	H	L	H	Reverse
H	H	L	L	Brake

Note: x represents 1 or 2.

Typical waveform diagram



Note: x represents 1 or 2.

Absolute Maximum Ratings (TA=25ÿ)

		symbol	value	unit
Parameters Maximum logic control		VCCx(MAX)	5.5	V
supply voltage Maximum power		VDDx(MAX)	9	
supply voltage Maximum applied		VOUT(MAX)	VDDx	
output voltage Maximum applied input voltage		VIN(MAX)	VCCx	
Maximum peak output current	1 channel	IOUT(PEAK)	3	A
	2 channels		3	
Maximum power		PD	1.5	IN
dissipation Junction to ambient thermal resistance	SOP16 package Operating	ÿJAD	80	ÿ/W
temperature range Junction		Topr	-20~+85	ÿ
		TJ	150	ÿ
temperature Storage		Tstg	-55~+150	ÿ
temperature Soldering temperature		TLED	260ÿ, 10 sec	
ESD (Note 3)			4000	V

Note: (1) x represents 1 or 2.

(2) The maximum power consumption calculation formula under different ambient temperatures is: PD = (150°C-TA) / ÿJA

TA is the ambient temperature of the circuit, ÿJA is the thermal resistance of the package, and 150°C is the maximum operating junction temperature of the circuit.

(3) Calculation method of circuit power consumption: P = I2xR

Where P is the circuit power consumption, I is the continuous output current, and R is the on-state internal resistance of the circuit. The circuit power consumption P must be less than the maximum power consumption PD

(4) Human body model, 100pF capacitor discharges through 1.5Kÿ resistor.

Recommended Operating Conditions (TA = 25°C)

		Symbol	Minimum	Typical value (VDD=6.5V)	Maximum value	unit
Parameters Logic and Control Supply		VCCx	1.8	-	5	V
Voltage Power Supply		VDDx	2	-	8.6	V
Voltage Simultaneous Operation Per Channel	1 channel	IOUT1		1.3		A
continuous output current	2 channels	IOUT2 work		1.3		
independently per channel	1 Channel	IOUT1		1.6		
continuous output current	2 Channel	IOUT2 Note:		1.6		

(1) x represents 1 or 2.

(2) The logic control power supply VCC and the power supply VDD are completely independent and can be powered separately.

The circuit will enter standby mode.

(3) The continuous output current test condition is: the circuit is mounted on the PCB for testing.

(4) The maximum continuous output current is related to the ambient temperature. The maximum continuous current of the circuit at 40°C is about 25°C less than that at 25°C.

7%ÿ

Electrical characteristics parameter table

(TA=25ÿ, VCCx=3V, VDDx =6V unless otherwise specified)

Parameter Symbol Condition Power Parameter			Min Typ Max Unit			
VCCx Standby Current	IVCCST	INAx=INBx= L;VCCx=5V;	-	0	10	uA
VDDx Standby Current	IVDDST	VDDx=8V; output floating	-	0	10	
VCCx Quiescent supply current	IVCCx	INAx=H OR INBx=H; output floating	-	190	-	uA
VDDx Quiescent supply current	IVDDx	INAx=H OR INBx=H; output floating Input logic level	-	90	-	
Input high level	VINH		2	-	-	V
Input low level Input	VINL		-	-	0.8	
level hysteresis Input	VHYS			0.6		
high level current Input pull-	IINH	VINH=3V,VCCx=3V		200		uA
down resistance Power	TOO	VINH=3V,VCCx=3V		15		Kÿ
tube conduction internal resistance						
1 Channel On-Resistance	RON1	IO=±200mA VDD1=6.5V TA=25ÿ		0.3		Oh
		IO=±1.6A VDD1=6.5V TA=25ÿ		0.4		
2-channel on-resistance	RON2	IO=±200mA VDD2=6.5V TA=25ÿ		0.3		
		IO=±1.6A VDD2=6.5V TA=25ÿ		0.4		
Protection function parameters						
Thermal Shutdown	TSD		-	150	-	ÿ
Temperature Point Thermal	TSDH		-	20	-	

Shutdown Temperature Hysteresis Notes: 1. The delay of the same direction signal from input B to output B is the same as the delay of the same direction signal from input A to output A in the above table.

2. The delay of the reverse signal from input B to output A is the same as the delay of the reverse signal from input A to output B in the above table.

3. x represents 1 or 2.

Typical application circuit diagram

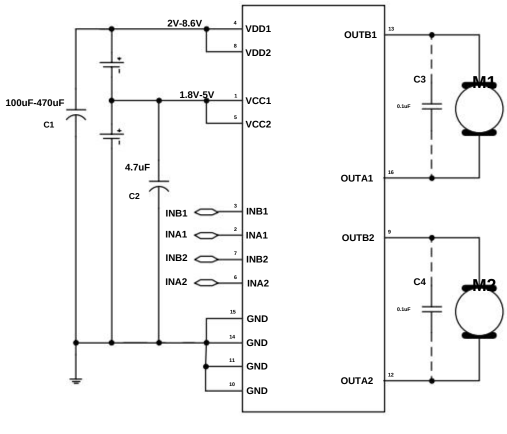


Figure 1 MX1616H typical application circuit diagram

Special Notes:

In Figure 1, capacitor C1 is a decoupling capacitor between the power supply and the ground. The capacitance of capacitor C1 can be adjusted according to different application conditions. There are different options, which are specified as follows:

A. When the VDDx voltage is less than 7.2V (4 new dry batteries) and the peak current does not exceed 2.5A, capacitor C1 can be omitted.

B. When the VDDx voltage is between 7.2V and 8.5V and the peak current exceeds 2.5A, capacitor C1 cannot be omitted and needs to be adjusted according to the actual In the case of motors, the value of capacitor C1 is selected between 100uF-470uF.

C. There is no restriction on the type of capacitor C1, which can be a ceramic capacitor or an electrolytic capacitor.

The logic power supply VCCx to ground capacitor C2 must be at least 4.7uF. In actual application, there is no need to add a separate capacitor close to the chip. Shared with other control chips (RX2, MCU, etc.). If there is no capacitor between VCCx and ground, when the circuit enters the overheat protection mode due to overload, the circuit The circuit may enter a locked state. After entering the locked state, the state of the input signal must be changed again before the circuit can return to normal. If there is more than 4.7uF capacitance between VCCx and ground, the circuit will not lock up.

The 0.1uF capacitors (C3, C4) between the drive circuit OUTAx and OUTBx in Figure 1 represent the capacitors connected to the motor terminals. Add to.

Application Notes

1. Basic working mode

a) Standby mode

In standby mode, INAx = INBx = L. All internal circuits including the driver power tube are in shutdown state. The circuit consumption is extremely low. At this time, the motor output terminals OUTAx and OUTBx are both in high impedance state.

b) Forward mode

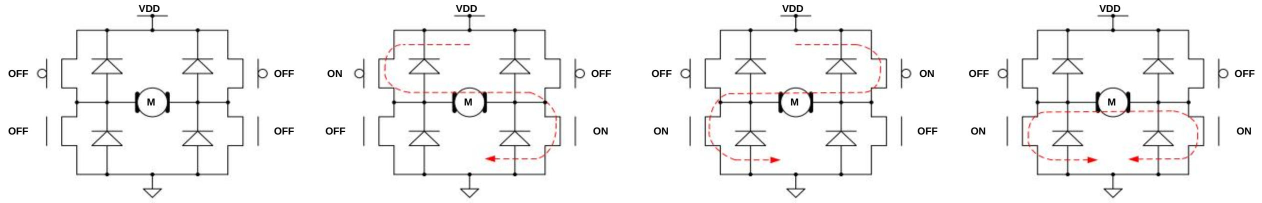
The forward mode is defined as: INAx = H, INBx = L, at this time the motor drive terminal OUTAx outputs a high level, and the motor drive terminal OUTBx outputs a low level. When the motor drive current flows from OUTAx to the motor and from OUTBx to the ground, the motor rotation is defined as forward mode.

c) Reversal pattern

The definition of the reverse mode is: INAx = L, INBx = H, at this time the motor drive terminal OUTBx outputs a high level, and the motor drive terminal OUTAx outputs a low level. When the voltage is high, the motor drive current flows from OUTBx into the motor and from OUTAx to the ground. At this time, the rotation of the motor is defined as the reverse mode.

d) Braking mode

The brake mode is defined as: INAx = H, INBx = H. At this time, the motor drive terminals OUTAx and OUTBx both output low level, and the motor storage The energy will be quickly released through the OUTAx NMOS or OUTBx NMOS, and the motor will stop rotating in a short time. The circuit will consume static power in car mode.

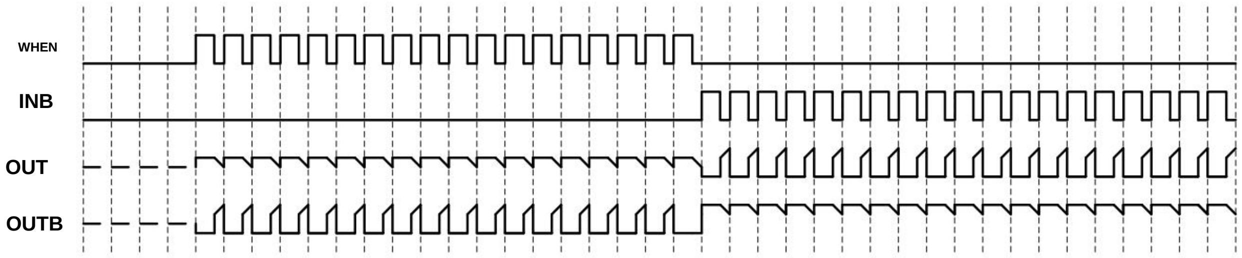


a) Standby mode b) Forward mode c) Reversal pattern d) Braking mode

e) PWM Mode **A**

When the input signal INAx is a PWM signal and INBx=0 or INAx=0 and INBx is a PWM signal, the rotation speed of the motor will be affected by the PWM. In this mode, the motor drive circuit switches between on and standby modes. In standby mode, all power The power tubes are in the off state, and the energy stored in the motor can only be released slowly through the body diode of the power MOSFET.

Note: Due to the high impedance state in the working state, the motor speed cannot be accurately controlled by the duty cycle of the PWM signal. If the frequency of the PWM signal is too high, the motor may not start.

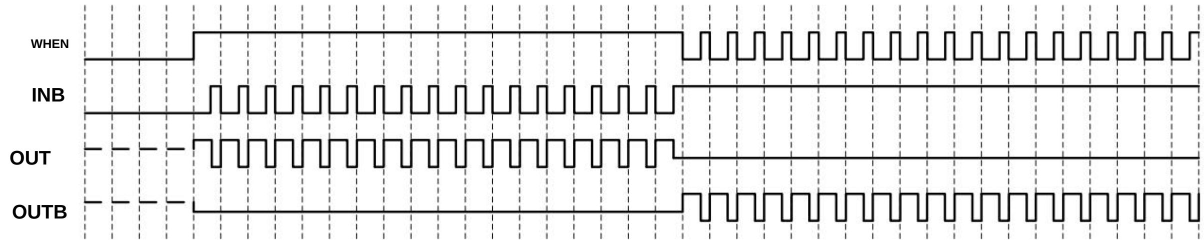


PWM mode A signal waveform diagram

f) PWM Mode **B**

When the input signal INAx is a PWM signal and INBx=1 or INAx=1 and INBx is a PWM signal, the rotation speed of the motor will be affected by the PWM. In this mode, the motor drive circuit output is between the conduction mode and the brake mode. In the brake mode, the motor stores The energy is quickly released through the low-side NMOS tube.

Note: Due to the braking state in the working state, the motor energy can be released quickly, and the motor speed can be accurately controlled by the duty cycle of the PWM signal. However, it must be noted that if the PWM signal frequency is too low, the motor will enter the braking mode and cannot rotate continuously and smoothly. To reduce motor noise, it is recommended that the PWM signal frequency be greater than 10KHz and less than 50KHz.



PWM mode B signal waveform diagram

2. Anti-common conduction circuit

In the full-bridge drive circuit, the state in which the high-side PMOS power tube and the low-side NMOS power tube in the half-bridge are turned on at the same time is called common conduction.

The common-mode conduction will cause a transient large current from the power supply to the ground, which will cause additional power loss and in extreme cases will burn the circuit.

By built-in dead time, common mode conduction can be avoided. The typical dead time is 300ns.

3. Overheat protection circuit

When the junction temperature of the driver circuit exceeds the preset temperature, the TSD circuit starts to work. At this time, the control circuit forces all output power tubes to be turned off, and the driver circuit

The circuit output enters a high impedance state. Thermal hysteresis is designed in the TSD circuit. Only when the junction temperature of the circuit drops to a preset temperature (typical value 130°C), the circuit will

The circuit returns to normal working condition.

4. Maximum continuous power consumption of the drive circuit

The motor drive circuits of this series are designed with overheat protection circuits. Therefore, when the power consumption of the drive circuit is too large, the circuit will enter the thermal shutdown state.

Shutdown mode, the motor will not work normally in the thermal shutdown state. The calculation formula for the maximum continuous power consumption of the drive circuit is:

PM=(150ÿ-TA)/ÿJA

Where 150ÿ is the preset temperature point of the thermal shutdown circuit, TA is the ambient temperature of the circuit (ÿ), and ÿJA is the thermal resistance from the junction to the environment of the circuit (single

ÿ/W).

Note: The maximum continuous power consumption of the drive circuit is related to factors such as ambient temperature, packaging form, and heat dissipation design.

No direct relationship.

5. Driving circuit power consumption

The on-resistance of the power MOSFET inside the motor drive circuit is the main factor affecting the power consumption of the drive circuit. The calculation formula for the power consumption of the drive circuit is:

Example: PD=IL 2 xRON

Where IL represents the output current of the motor drive circuit, and RON represents the on-resistance of the power MOSFET.

Note: The on-resistance of the power MOSFET increases with the increase of temperature. It is necessary to consider this when calculating the maximum continuous output current and power consumption of the circuit.

The temperature characteristics of the on-resistance must be considered.

6. Maximum continuous output current of the drive circuit

The maximum continuous output current of the driving circuit can be calculated based on the maximum continuous power consumption of the driving circuit and the power consumption of the driving circuit. The calculation formula is:

$$I_L \text{ ÿ ÿ} \sqrt{150 \text{ ÿ }_{FACING} \text{ÿ} /(\text{ÿ}_{AND} \text{ ÿ }_{WORSE})}$$

RONT is the on-resistance of the power MOSFET after considering the temperature characteristics.

Note: The maximum continuous output current of the drive circuit is related to the ambient temperature, packaging form, heat dissipation design and the on-resistance of the power MOSFET.

And other factors.

7. Motor internal resistance selection

The above analysis shows that the maximum continuous power consumption of the motor drive circuit is limited. If the internal resistance of the motor driven by the motor drive circuit is very small, its stall

If the current exceeds the maximum continuous output current that the motor drive circuit can withstand, it will easily cause the motor drive circuit to enter an overheating shutdown state.

The toy car will shake when it is running or moving forward and backward repeatedly. When selecting the motor drive circuit, the internal resistance of the motor must be considered.

Note: x represents 1 or 2.

Special considerations

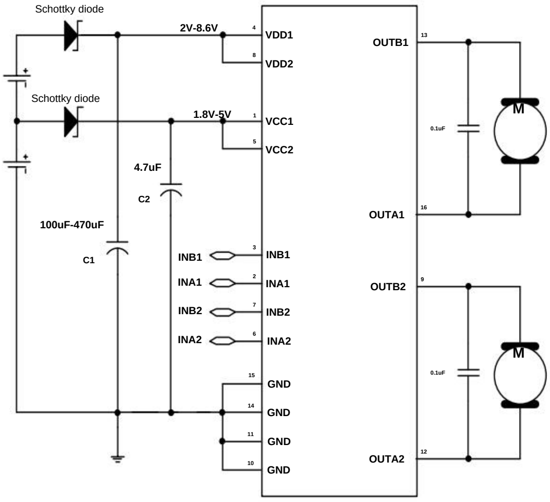
1. Reverse connection of power supply and ground

Connecting the power supply and ground wires in reverse will damage the circuit and cause the plastic package to smoke in severe cases.

Connecting two power Schottky diodes to the positive terminal of the battery can prevent circuit damage caused by reverse connection of the battery.

The continuous current capability must be greater than the continuous current of the motor stall, otherwise the Schottky diode will be damaged due to overheating.

The reverse breakdown voltage must be greater than the maximum power supply voltage. If the reverse breakdown voltage is too small, when the battery is reversely connected, the Schottky diode will be broken down and cause burn.



2. Power supply VDD1, VDD2 to ground decoupling capacitor (C1)

The driving circuit requires the addition of power supply VDD1, VDD2 to ground decoupling capacitor C1 (refer to application circuit diagram 1) has two main functions: 1) Absorb the energy released by the motor to the power supply, stabilize the power supply voltage, and avoid circuit breakdown due to overvoltage; 2) When the motor starts or rotates forward or reverse quickly At the moment of switching, the motor needs a large current to start quickly. Due to the battery response speed and the long connecting wires, it is often not possible to start immediately. That is, a transient large current is output, and at this time it is necessary to rely on the energy storage capacitor near the motor drive circuit to release the transient large current.

According to the energy storage characteristics of capacitors, the larger the capacitance, the smaller the voltage fluctuation in the same time. Therefore, in high voltage and high current application conditions, The recommended capacitor C1 value is 470uF. It is recommended to select the capacitor value according to the specific application, but the capacitor C1 value needs to be at least 100uF.

3. Electrostatic protection

The input/output ports of the circuit use CMOS devices, which are sensitive to electrostatic discharge. Although electrostatic protection circuits are designed, they are still Anti-static measures should be taken during packaging, processing and storage, especially during processing.

4. Output short circuit to ground, output short circuit

In normal operation, when the high-level output terminal of the circuit is short-circuited to the ground or OUTAx and OUTBx are short-circuited, the circuit A huge current will flow through, generating a huge power consumption, triggering the overheat shutdown circuit inside the circuit, thus protecting the circuit from burning out immediately. The overheat protection circuit only detects the temperature, but not the transient current passing through the circuit. When the output is short-circuited to the ground, the current is extremely large, which can easily cause circuit damage. Avoid output short circuit to ground during use. Adding current limiting measures during testing can avoid similar damage.

5. Output short circuit to power supply

During normal operation, when the low-level output terminal of the circuit is short-circuited with the power supply, the circuit will be damaged.

6. Motor stall

In normal operation, when the load motor of the drive circuit is stalled, if the stall current exceeds the maximum continuous current of the drive circuit, If the stall current is much greater than the maximum peak current, the drive circuit will enter overheat protection mode to prevent circuit damage. However, if the stall current is much greater than the maximum peak current, the circuit is more likely to be damaged. bad.

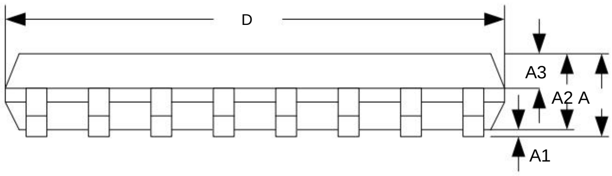
7. The peak current greatly exceeds the rated value

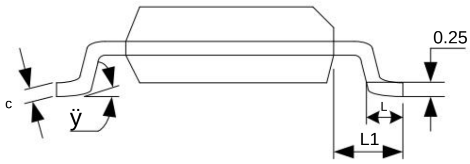
When the maximum operating voltage is approached or exceeded and the peak current greatly exceeds the absolute maximum peak current, the chip may also burn out.

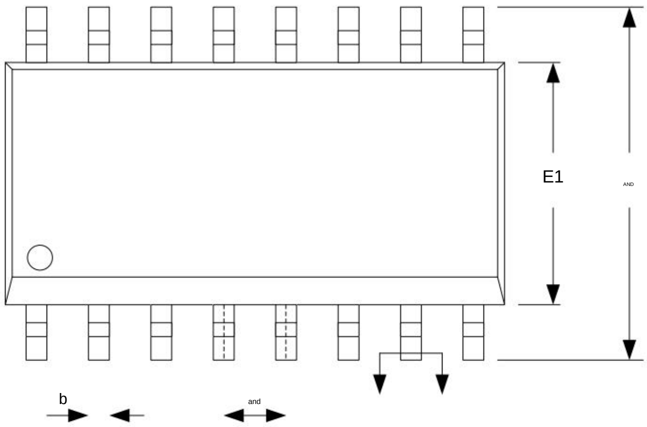
Note: x represents 1 or 2.

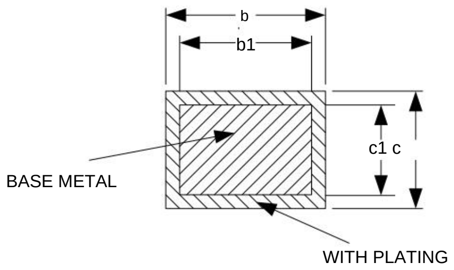
Package Dimensions

SOP16ÿ









SYMBOL	MILLMETER		
	MIN	NAME	MAX
A			1.77
A1	0.08	0.18	0.28
A2	1.20	1.40	1.60
A3	0.55	0.65	0.75
b	0.39		0.48
b1	0.38	0.41	0.43
c	0.21		0.26
c1	0.19	0.20	0.21
D	9.70	9.90	10.10
AND	5.80	6.00	6.20
E1	3.70	3.90	4.10
and	1.27BSC		
L	0.5	0.65	0.80
L1	1.05BSC		
ÿ	0°		8°

Revision History

V1.0 Initial version 2020-09-22

V1.1 Modify some parameters and error descriptions 2020-11-25

V1.2 Maximum power supply voltage changed to 9V 2020-12-11

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