Dual-channel brushed DC motor drive circuit

MX1508

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 1500 mA power tube internal resistance 0.36 ohm

— 2 channels 800 mA power tube internal resistance 0.47 ohm

ÿ Internal integrated freewheeling diode

— No external freewheeling diode required

ÿ Smaller input current

— Integrated about 15K pull-down resistor

— 3V drive signal average 200uA input current

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

ÿ Antistatic grade: 3KV (HBM)

Application

ÿ Toy motor driver powered by 2-6 AA/AAA dry batteries

ÿ Toy motor driver powered by 2-6 NiMH/NiCd rechargeable batteries

move

ÿ Motor drive powered by 1-2 lithium batteries

Overview

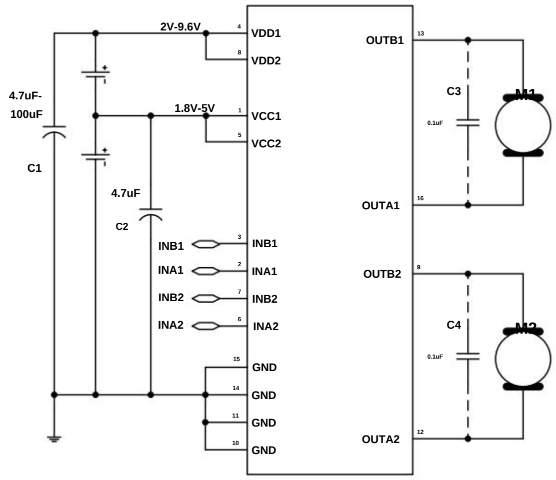
This product adopts H-bridge circuit structure design and adopts high reliability The power tube technology is particularly suitable for driving inductive loads such as coils and motors. The circuit integrates N-channel and P-channel power MOSFETs. The voltage range covers 2V to 9.6V. 27ÿ, VDD=6.5V, two Under the condition that the channels work simultaneously, the maximum continuous output current of the two channels is Up to 0.8A, the maximum peak output current reaches 1.5A; 1 channel maximum The maximum continuous output current reaches 1.5A, and the maximum peak output current reaches 2.5A.

This circuit is a power device and 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, (typical value 150ÿ), generates a power tube shutdown signal, turns off the load power flow to avoid continuous temperature rise due to abnormal use, which may cause This can cause serious safety accidents such as plastic packaging smoking and fire. The temperature hysteresis circuit ensures that the circuit returns to a safe temperature before Allows the power tube to be controlled again.

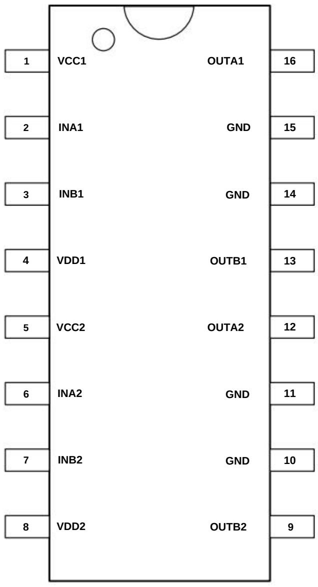
Ordering Information

Product Model	Encapsulation	Operating temperature
MX1508	SOP16	-20ÿ ~ 85ÿ

Typical application diagram



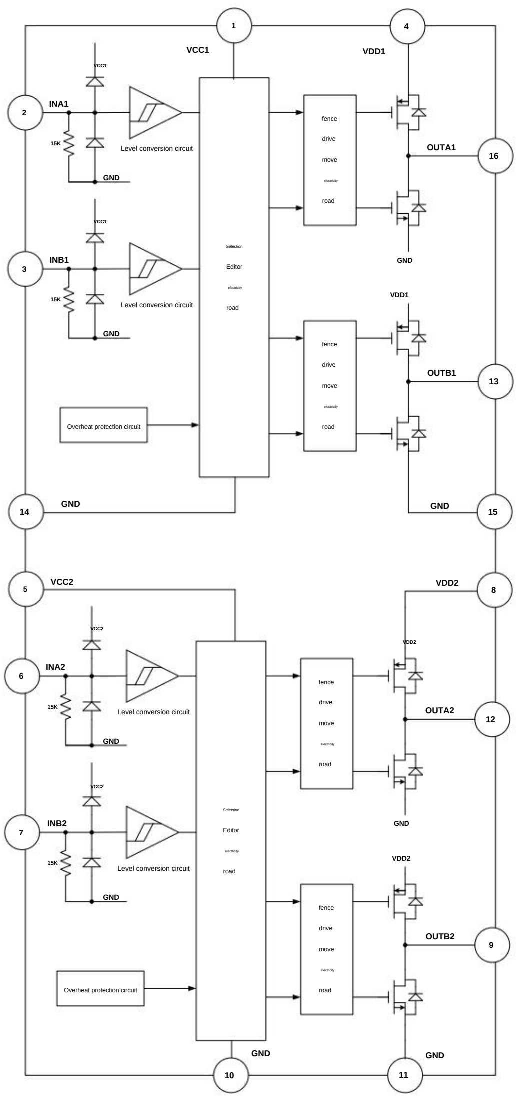
Pinout



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 terminal
12	OUTA2	O	2-channel forward output
13	OUTB1	O	1 channel inverted output
14	GND	-	Ground
15	GND	-	Ground terminal
16	OUTA1	THE	1 channel forward output

Functional Block Diagram

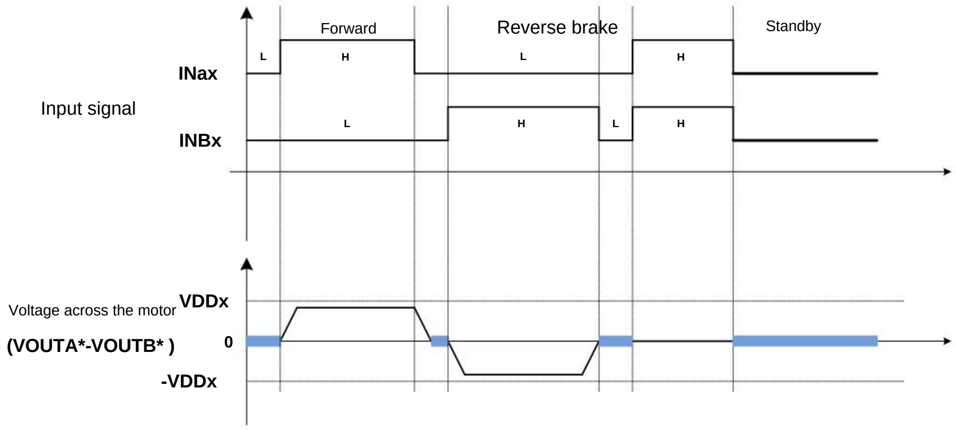


Logic truth table

INax	INBx	OUTAx	OUTBx	Function
L	L	WITH	WITH	Standby
H	L	H	L	Forward
L	H	L	H	Reversal
	H	L	L	brake

H 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 power		VCCx(MAX)	7	In
supply voltage Maximum power		VDDx(MAX)	10	
supply voltage Maximum external		VOUT(MAX)	VDD	
output voltage Maximum external input voltage		WIN(MAX)	VCC	
Maximum peak output current	1 channel	IOUT(PEAK)	2.5	A
	2 channels		1.5	
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		Test	-55~+150	ÿ
temperature Soldering temperature		TLED	260°C, 10 seconds	
ESD (Note 3)			3000	In

Note: (1) x represents 1 or 2.

(2) The maximum power consumption calculation formula at different ambient temperatures is: PD=(150ÿ-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 = I2 x R

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 is discharged through 1.5Kÿ resistor.

Recommended operating conditions

		Symbol Minimum Typical Value (VDD=6.5V) Maximum Value Unit				
(TA=25ÿ) Parameters Logic and		VCCx	1.8	-	5	In
control Power supply		VDDx	2	-	9.6	In
voltage Power supply voltage 2 Channel not working 1 channel continuous current				1.75		A
IOUT1 1 channel not working 2 channel continuous current IOUT2 2 channels				1.5		
continuous output 0.8A 1 channel continuous current IOUT2 Note: (1), x represents 1				1.5		

or 2.

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

The circuit will enter standby mode.

(3) The continuous output current test condition is: the circuit is mounted on the PCB for testing, and the test PCB board size of the SOP16 package is 21mmx19mm.

(4) The maximum continuous output current is related to the ambient temperature. The maximum continuous current of the circuit at 40°C is about 20% lower than that at 25°C.

7%ÿ

Electrical characteristics parameter table

(TA=25ÿ, VCC=3V, VDD=6V unless otherwise specified)

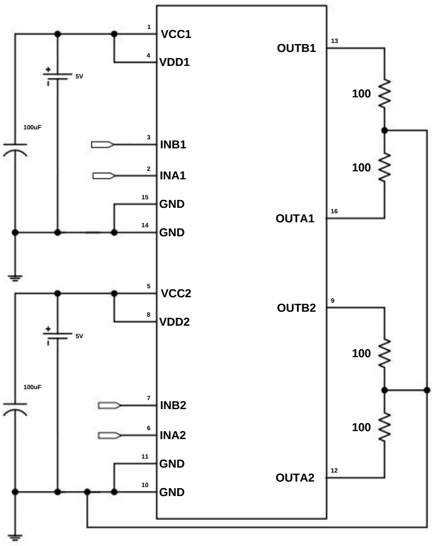
Parameters	Symbol	Condition	Min.	Typ.	Max.	Unit
Power parameters						
VCCx standby current	IVCCST	INA1=INB2= INA1=INB2=L;VCC=7V;	-	0	10	a
VDDx standby current	IVDDST	VDD=10V; output floating	-	0	10	
VCCx Quiescent Supply Current	IVCC	INAx=H OR INBx=H; Output Floating	-	145	-	a
VDDx Quiescent Supply Current	IVDD	INAx=H OR INBx=H; Output Floating Input Logic Level	-	88	-	
Input high level	VINH		0.6*VCC	-	-	In
Input low level Input	VINYL		-	-	0.6	
level hysteresis Input	VHYS			0.4		
high level current Input pull-	IINH	VINH =3V,VCC=3V		200		a
down resistance Power	RIN	VINH=3V,VCC=3V		15		Kÿ
tube conduction internal resistance						
1 channel on-resistance	RON1	IO=±200mA VDD1=6.5V TA=25ÿ		0.32		Oh
		IO=±1500mA VDD1=6.5V TA=25ÿ		0.36		
2-channel on-resistance	RON2	IO=±200mA VDD2=6.5V TA=25ÿ		0.45		
		IO=±800mA VDD2=6.5V TA=25ÿ		0.47		
Protection function parameters						
Thermal Shutdown	TSD		-	150	-	ÿ
Temperature Point Thermal Shutdown Temperature			-	20	-	
Hysteresis TSDH Time Parameters - 1 **Channel (VCC1=VDD1=5V)**						
Output rise time	tr	INB1=GND,INA1 input 20KHZ PWM		146		ns
Output fall time Input	tf	OUTA1 is connected to a 100 ohm load and then to GND.		30		
A to output A same direction signal	trr	INB1=GND,INA1 input 20KHZ PWM		167		ns
Number delay	tff	OUTA1 is connected to a 100 ohm load and then to GND.		66		
Input A to output B reverse signal	trf	INB1=5V,INA1 inputs 20KHZ PWM signal		64		ns
Number delay	tfr	OUTB1 is connected to a 100 ohm load and then to GND.		169		
Time parameters - 1 **channel (VCC2=VDD2=5V)**						
Output rise time	tr	INB2=GND,INA2 input 20KHZ PWM		94		ns
Output fall time Input	tf	OUTA2 is connected to a 100 ohm load and then to GND.		19		
A to output A same direction signal	trr	INB2=GND,INA2 input 20KHZ PWM		111		ns
Number delay	tff	OUTA2 is connected to a 100 ohm load and then to GND.		43		
Input A to output B reverse signal	trf	INB2=5V,INA2 inputs 20KHZ PWM signal		42		ns
Number delay	tfr	OUTB2 is connected to a 100 ohm load and GND		113		

Note: 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.

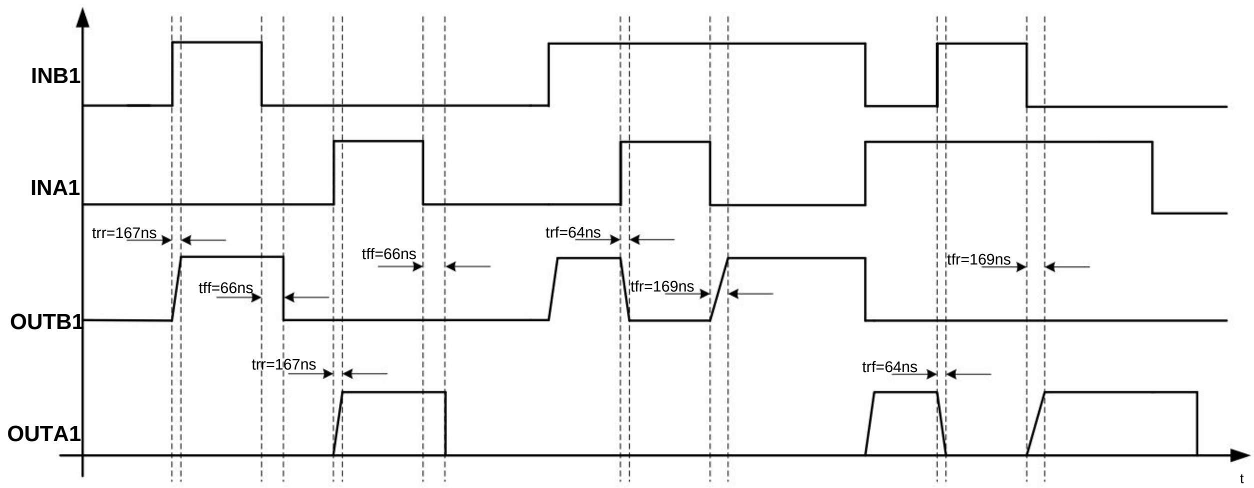
2. The delay of the reverse signal from input B to output A is the same as the delay of the reverse signal from input A to output B in the above table.

3. x represents 1 or 2.

Test schematic

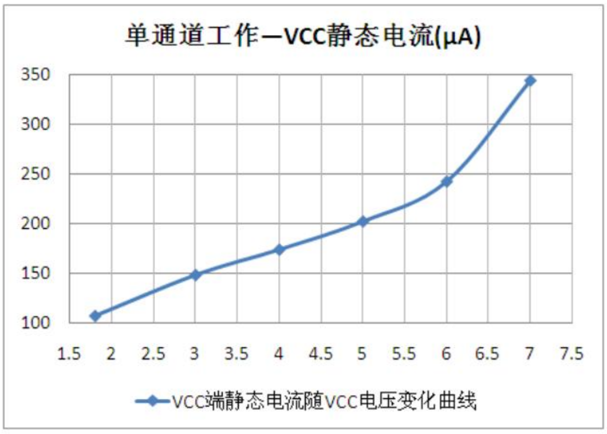


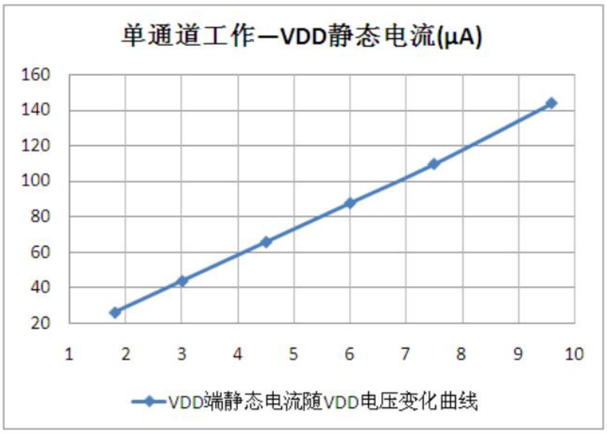
Time parameter test schematic diagram

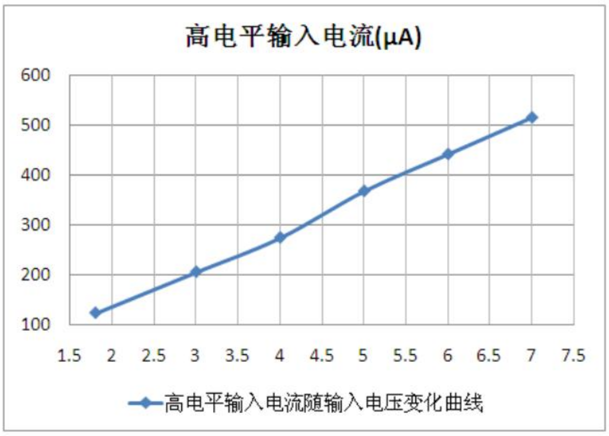


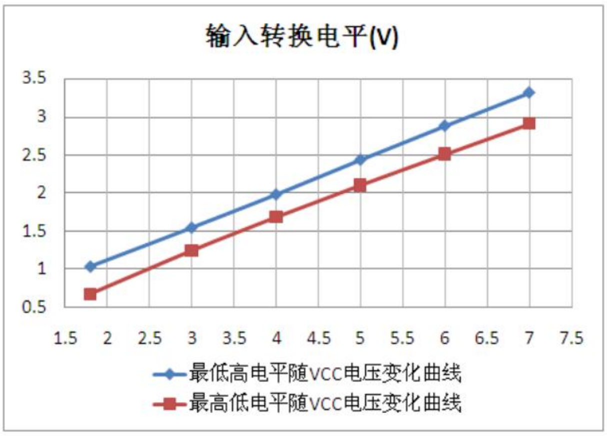
Time parameter definition

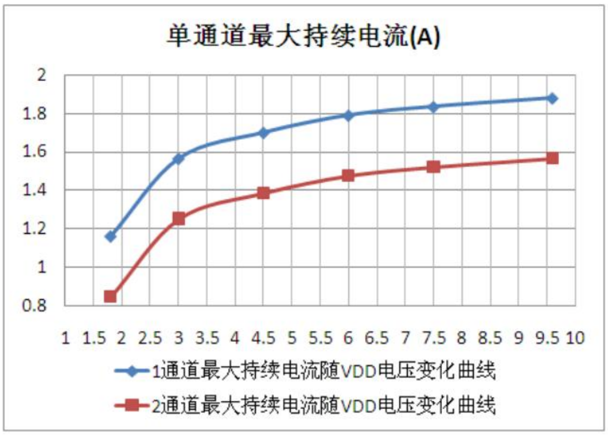
Electrical characteristics curve

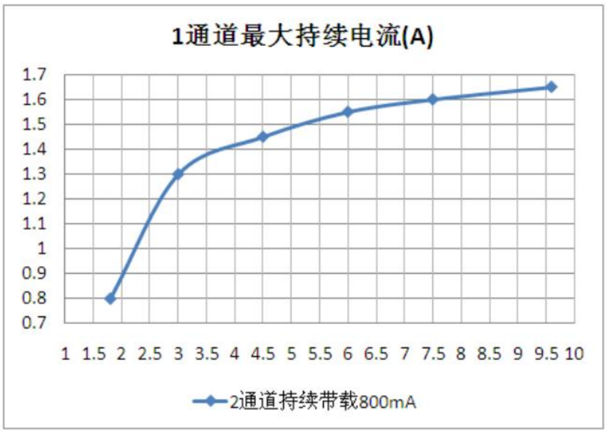


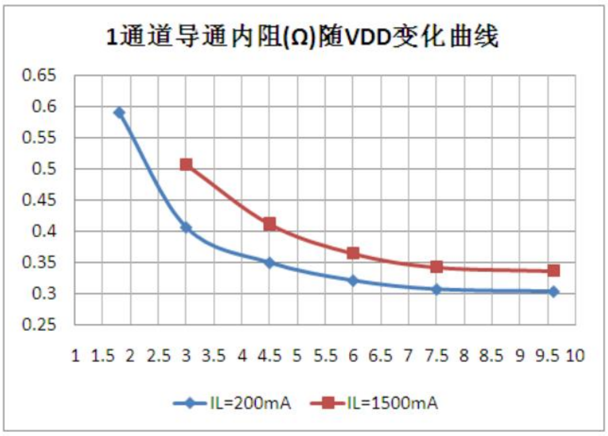


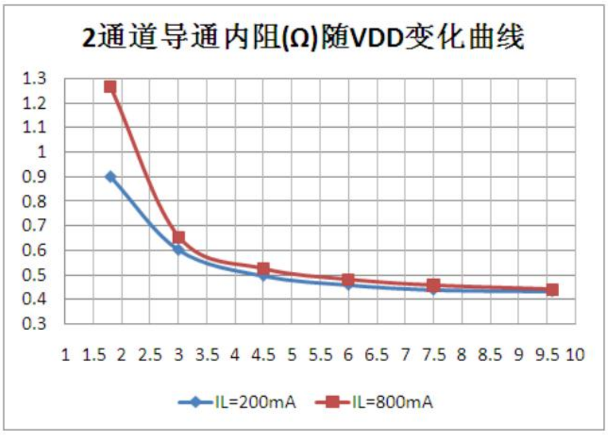












Typical application circuit diagram

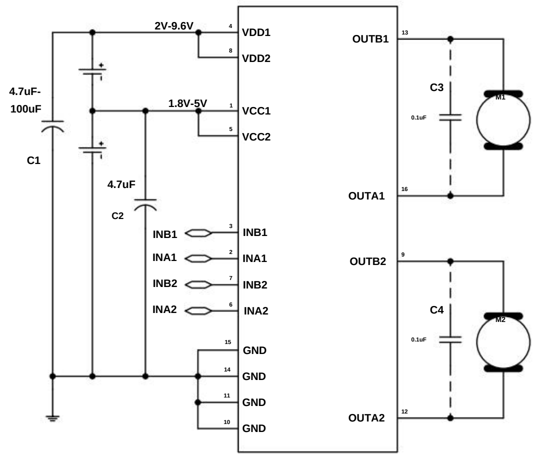


Figure 1 MX1508 typical application circuit diagram

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 cell batteries) and the peak current does not exceed 1.5A, capacitor C1 can be omitted.

B. When the VDDx voltage is between 7.2V and 9.6V and the peak current exceeds 1.5A, capacitor C1 cannot be omitted and needs to be adjusted according to the actual situation.

In the case of motors, the value of capacitor C1 is selected between 47uF and 100uF.

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 input signal state 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 enter the locked state.

The 0.1uF capacitors (C3, C4) between the OUTAx and OUTBx of the drive circuit in Figure 1 represent the capacitors connected to both ends of the motor and do not need to be connected separately.

Add to.

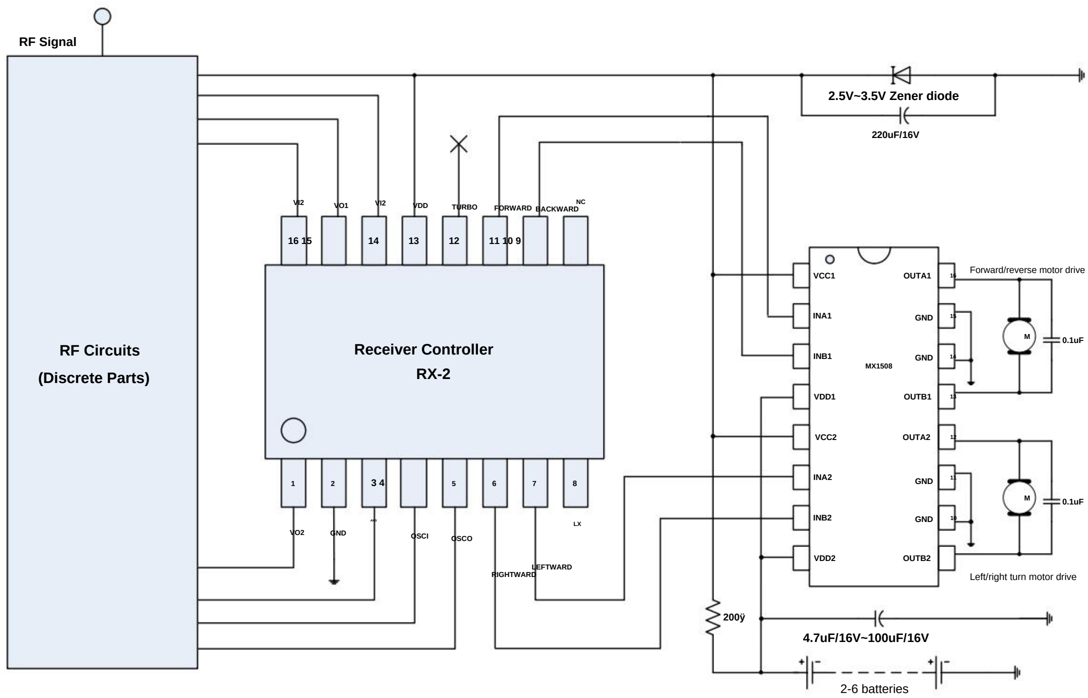


Figure 2 2-6 battery powered toy remote control car motor drive application circuit diagram

As shown in Figure 2, the motor drive application circuit diagram, in which the steering wheel drive current is small, can choose the MX1508 2-channel drive, the rear wheel The motor drive current is relatively large, so the MX1508 1-channel drive can be selected.

The capacitance of the VDDx to ground decoupling capacitor in Figure 2 should be selected according to the actual usage. The higher the VDDx voltage, the greater the motor current, and the larger the capacitance. The larger the value, the better. The recommended value of capacitor C1 is between 4.7uF and 100uF.

VCCx and VDDx must be wired separately. VCCx only accepts a static voltage of 5V or less and must share the same power supply with the main control chip. Otherwise, the motor will The electromotive force generated by switching may break down the logic part, and separate wiring is required even if the VDDx voltage is within 5V.

x represents 1 and 2.

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, the motor drive terminal OUTBx outputs a low level

When the level is low, the motor drive current flows from OUTAx to the motor and from OUTBx to the ground. At this time, the rotation of the motor is defined as the forward rotation 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, the motor drive terminal OUTAx outputs a low level

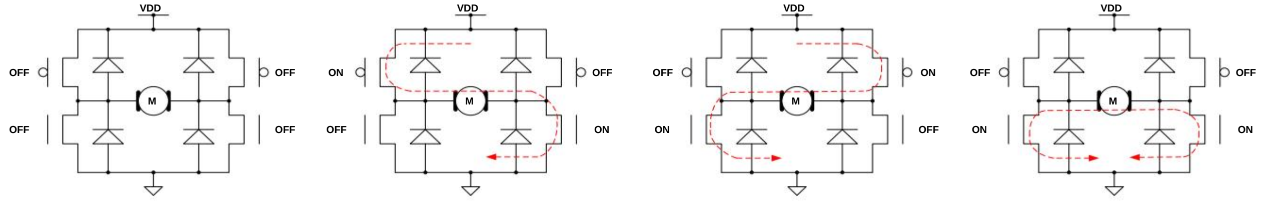
When the voltage is high, the motor drive current flows from OUTBx into the motor and from OUTAx to the ground. At this time, the rotation of the motor is defined as reverse mode.

d) Braking mode

The definition of brake mode is: INAx = H, INBx = H, at this time the motor drive terminals OUTAx and OUTBx both output low level, the motor storage

The energy will be released quickly through the OUTAx NMOS tube or OUTBx NMOS tube, and the motor will stop rotating in a short time.

The circuit will consume static power in car mode.



e) PWM Mode **A**

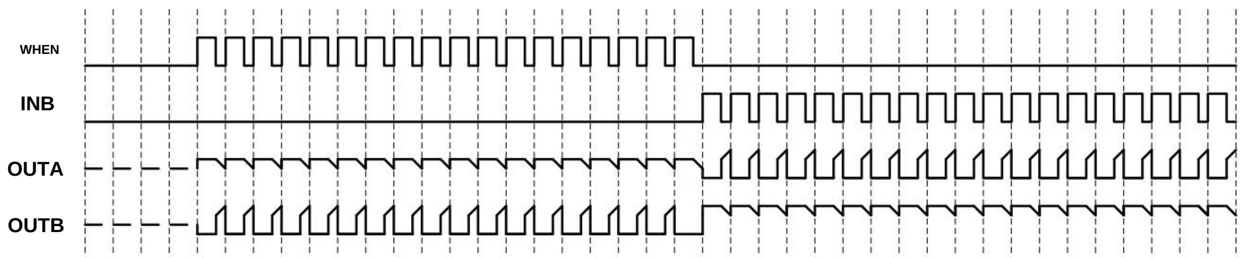
When the input signal INAx is a PWM signal and INBx=0 or INAx=0 and INBx is a PWM signal, the rotation speed of the motor will be affected by the PWM.

In this mode, the motor drive circuit switches between on and standby modes. In standby mode, all the

The power MOSFETs are all 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 resistance 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.

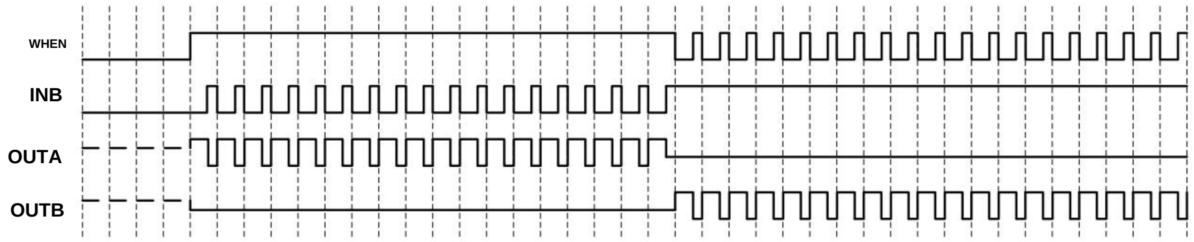
In this mode, the motor drive circuit output is between conduction mode and brake mode. In brake mode, the motor stores

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 will not be able to 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-mode 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 the common-mode conduction state. Common-mode conduction will cause a transient large current from the power supply to the ground. This current will cause additional power loss and, in extreme cases, will burn the circuit. Common-mode conduction can be avoided by using a built-in dead time. The typical dead time is 300ns. 3. Overheating protection circuit When the junction temperature of the drive circuit exceeds the preset temperature

(typical value is 150°C), the TSD circuit

starts to work. At this time, the control circuit forcibly shuts down all output power tubes, and the output of the drive circuit enters a high-impedance state. Thermal hysteresis is designed in the TSD circuit. Only when the junction temperature of the circuit drops to the preset temperature (typical value is 130°C) will the circuit return to normal operation. 4. Maximum continuous power consumption of the drive circuit

The motor drive circuits of this series are all 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. In shutdown mode, the motor will not work normally under thermal shutdown conditions. The formula for calculating 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 of the circuit to the environment (unit: 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, and has no direct relationship with the circuit's on-resistance. 5. Drive 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 formula for calculating the power consumption of the drive circuit is: PD=IL , where IL represents the output current of the motor drive circuit, and RON represents the on-resistance of the power ^{2} xRON

MOSFET. Note: The on-resistance of the power MOSFET increases with increasing temperature. 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:

$$I_L = \sqrt{(150 - T_A)/(\theta_{JA} * R_{ONT})}$$

RONT is the on-resistance of the power MOSFET after accounting for temperature characteristics. Note: The maximum

continuous output current of the driver circuit is dependent on factors such as ambient temperature, package type, heat dissipation design, and the on-resistance of the power MOSFET. 7. Motor Internal Resistance Selection The above analysis shows

that the maximum continuous power

consumption of the motor driver circuit is limited. If the motor driven by the motor driver circuit has extremely low internal resistance and its stall current exceeds the maximum continuous output current the motor driver circuit can withstand by a large margin, it can easily cause the motor driver circuit to enter overtemperature shutdown, causing the toy car to jitter when running or repeatedly moving forward and backward. The motor's internal resistance must be considered when selecting the motor driver circuit. Note: x represents 1 or 2.

Special considerations

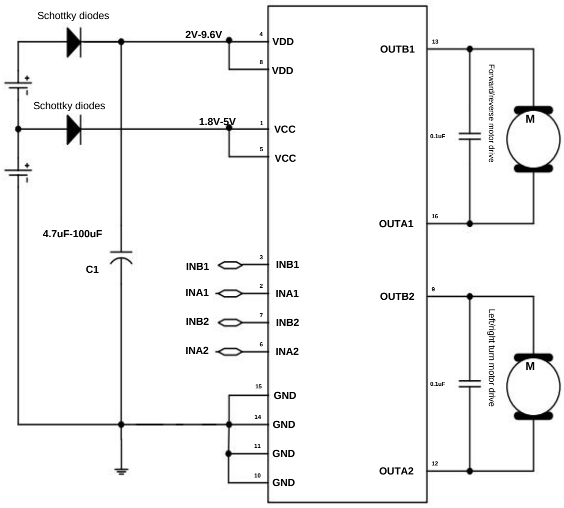
1. Reverse connection of power supply and ground

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

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 reversed, the Schottky diode will be broken down and cause burn.



2. Power supply VDD to ground decoupling capacitor (C1)

The drive circuit requires the addition of a power supply VDD to ground decoupling capacitor C1 (see application circuit diagram 1) which has two main functions: 1) absorbing the motor

The energy released to the power supply stabilizes the power supply voltage and prevents the circuit from breaking down due to overvoltage; 2) When the motor starts or switches between forward and reverse rotation quickly

Instantaneously, the motor needs a large current to start quickly. Due to the response speed of the battery and the long connection lead, it is often not possible to output instantaneous current immediately.

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 value of capacitor C1 is determined according to the actual use of the motor. The recommended value of capacitor C1 is between 4.7uF and 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 terminal short circuit

During normal operation, when the high level output terminal of the circuit is short-circuited with the ground or the OUTAx and OUTBx terminals are short-circuited, the circuit

A huge current will flow through, generating a huge power consumption, triggering the overheat shutdown circuit inside the circuit, thereby protecting the circuit from burning out immediately.

The overheat protection circuit only detects the temperature, but does not detect 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 short circuits to ground during use. Adding current limiting measures during testing can prevent 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

During normal operation, when the load motor of the drive circuit is locked, if the locked-rotor 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 the overheat protection mode to prevent the circuit from being damaged. However, if the stall current is much greater than the maximum peak current, the circuit is more likely to be damaged.

bad.

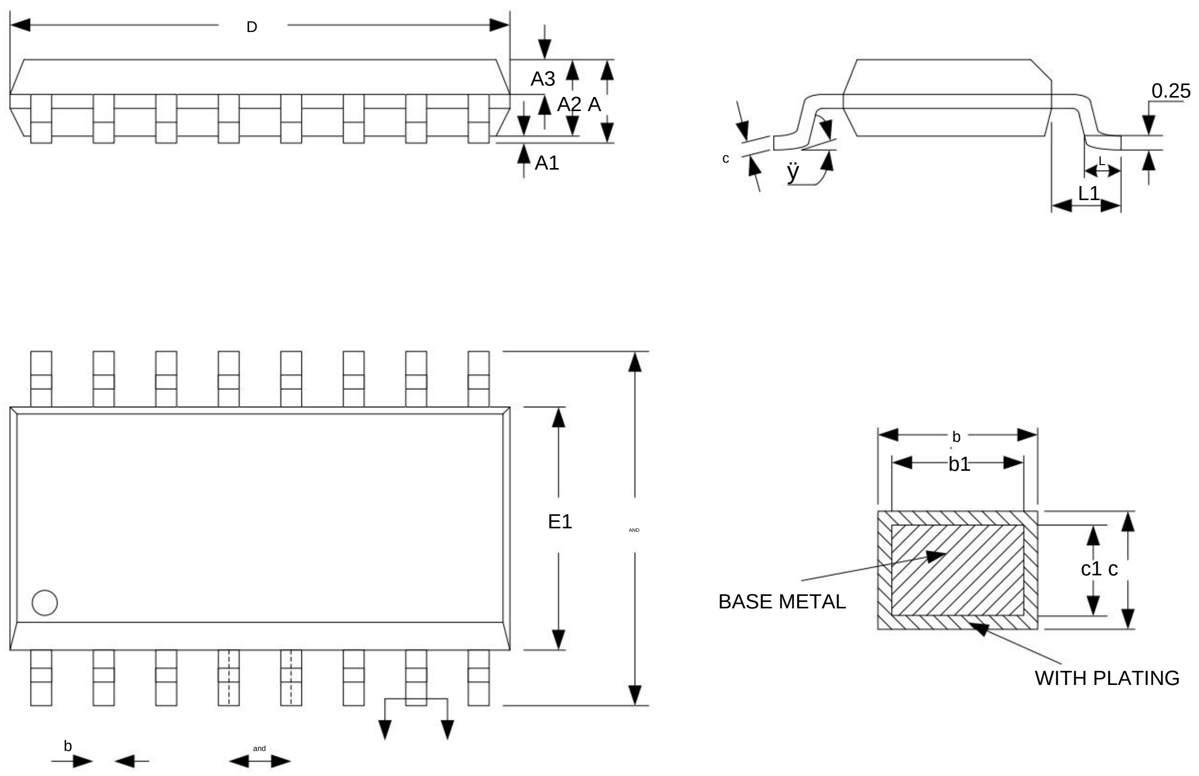
7. Peak current greatly exceeds the rated value

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	MILLIMETER		
	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°

Version History

V1.0 Initial version

V1.1 modified the application conditions of the circuit and added specific provisions for the power supply to ground decoupling capacitor.

V1.2 Added special provisions for VCC and VDD power-up

V1.3 Modify the homepage format. 2016-04-28