Dual 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 tubes

— 1 channel 1500 mA power tube internal resistance 0.36 ohm

— 2-channel 800 mA power tube internal resistance 0.47 ohms

ÿ Internal integrated freewheeling diode

— No need for external freewheeling diode

ÿ Smaller input current

— Integrated approximately 15K pairs of pull-down resistors

— 3V drive signal average 200uA input current

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

ÿ Antistatic level: 3KV (HBM)

Application scope

ÿ 2-6 AA/AAA dry battery-powered toy motor drives

ÿ 2-6-cell nickel-hydrogen/nickel-cadmium rechargeable battery-powered toy motor driver move

ÿ Motor drive powered by 1-2 lithium batteries

Overview

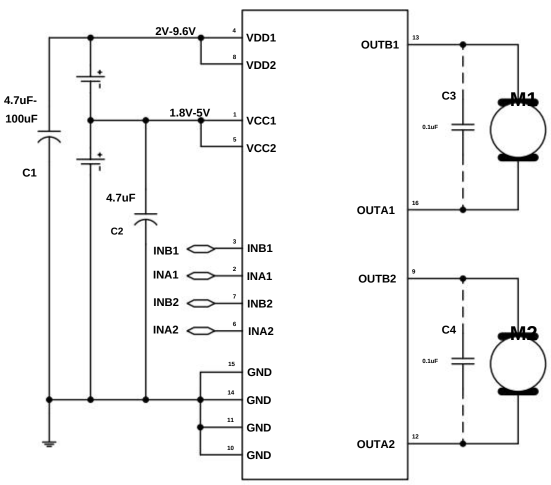
This product adopts H-bridge circuit structure design and adopts high reliability Power tube technology is particularly suitable for driving coils, motors and other inductive loads. The circuit integrates N-channel and P-channel power MOSFETs to work The voltage range covers 2V to 9.6V. 27ÿ, VDD=6.5V,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

This circuit is a power device and has a certain internal resistance. The circuit The heating and load current, the power tube conduction internal resistance and the ambient temperature closely related. The circuit design has a chip-level temperature detection circuit, 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 and turns off the load power flow to prevent the temperature from continuing to rise due to abnormal use, thereby causing Serious safety accidents such as smoke and fire in plastic packages may occur. Built-in chip The temperature hysteresis circuit ensures that the circuit returns to a safe temperature before Allows the power tube to be re-controlled.

Ordering Information

Product number	encapsulation	Operating temperature
MX1508	SOP16	-20ÿ ~ 85ÿ

Typical application diagram



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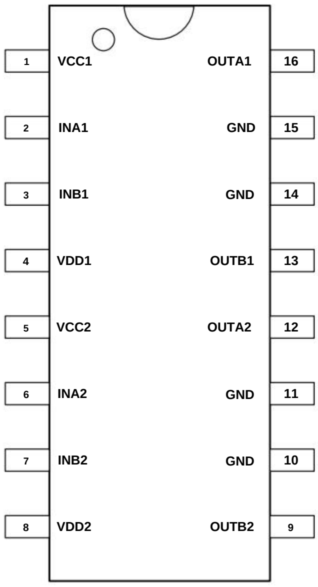
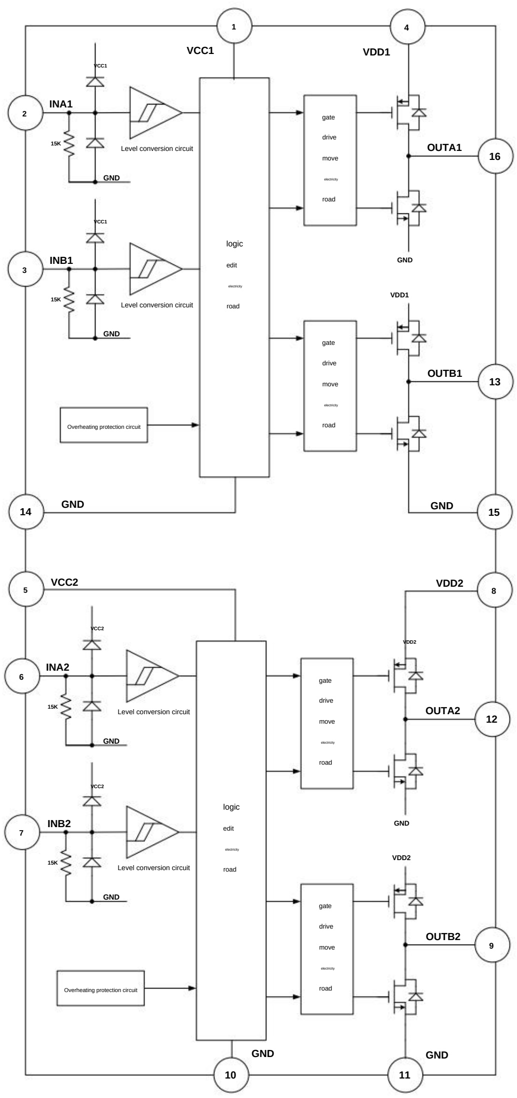
Pinout



Pin definition

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

Functional block diagram

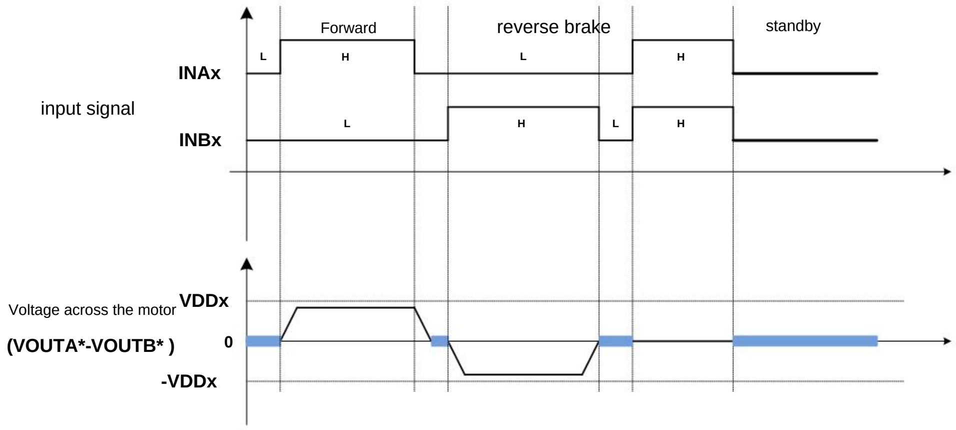


logical truth table

INAx	INBx	OUTAx	OUTBx	Function
L	L	WITH	WITH	standby
H	L	H	L	Forward
L	H	L	H	reverse
	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	
power supply voltage Maximum external		VOUT(MAX)	VDD	
output terminal voltage Maximum external input voltage		VIN(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		Tstg	-55~+150	ÿ
temperature Soldering temperature		TLED	260ÿ, 10 seconds	
ESD (Note 3)			3000	IN

Note: (1), x represents 1 or 2.

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

TA represents the ambient temperature at which the circuit operates, and ÿJA is the thermal resistance of the package. 150ÿ represents the maximum operating junction temperature of the circuit.

(3) Calculation method of circuit power consumption: P =I2 xR

Among them, P is the power consumption of the circuit, I is the continuous output current, and R is the on-resistance of the circuit. Circuit power consumption P must be less than the maximum power consumption PD

(4) Human body model, the 100pF capacitor is discharged through the 1.5Kÿ resistor.

Recommended working conditions (TA=25ÿ)

		Symbol	Minimum value	Typical value (VDD=6.5V)	Maximum value	Unit
Parameters Logic and control Power		VCCx	1.8	-	5	IN
supply voltage Power		VDDx	2	-	9.6	IN
supply voltage 2 Channel not working	1 Channel continuous current IOUT1 1 Channel			1.75		A
not working 2 Channel	continuous current IOUT2 2 Channel continuous output 0.8A 1			1.5		
Channel continuous current IOUT2 Note: (1), x represents 1 or 2.				1.5		

(2) The logic control power supply VCC and the power power supply VDD are completely independent internally 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 conditions are: 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 an ambient temperature of 40°C is approximately less than that at an ambient temperature of 25°C.

7%ÿ

Electrical Characteristics Parameter Table

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

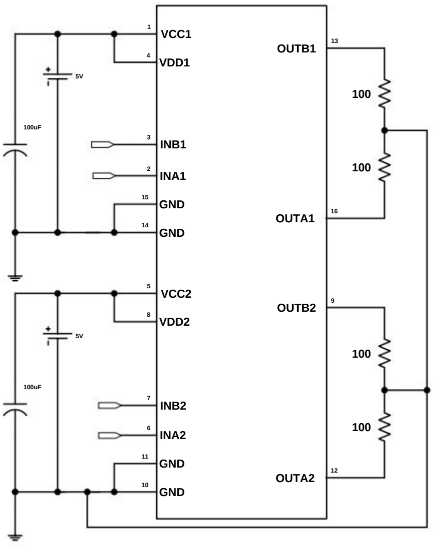
Parameters	sign	condition	Minimum value	Typical value	Maximum value	Unit
Power Parameters						
VCCx standby current	IVCCST	INA1=INB2= INA1=INB2=L;VCC=7V;	-	0	10	uA
VDDx standby current	IVDDST	VDD=10V; output floating	-	0	10	
VCCx quiescent power supply current	IVCC	INAx=H OR INBx=H; output floating	-	145	-	uA
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	VINL		-	-	0.6	
level hysteresis input	VHYS			0.4		
high level current input pull-	IINH	VINH=3V,VCC=3V		200		uA
down resistor power	RIN	VINH=3V,VCC=3V		15		Kÿ
tube conduction internal resistance						
1 channel conduction internal resistance	RON1	IO=±200mA VDD1=6.5V TA=25ÿ		0.32		Oh
		IO=±1500mA VDD1=6.5V TA=25ÿ		0.36		
2 channel conduction internal 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 parameter-1 **channel (VCC1=VDD1=5V)**						
Output rise time Output	tr	INB1=GND,INA1 input 20KHZ PWM		146		ns
fall time Input A to	tf	Signal. OUTA1 connects 100 ohm load to GND		30		
output A same direction signal	trr	INB1=GND,INA1 input 20KHZ PWM		167		ns
Delay	tff	Signal. OUTA1 connects 100 ohm load to GND		66		
Input A to output B reverse signal	trf	INB1=5V, INA1 inputs 20KHZ PWM signal		64		ns
Delay	tfr	Number. OUTB1 connects 100 ohm load to GND		169		
Time parameter-1 **channel (VCC2=VDD2=5V)**						
Output rise time Output	tr	INB2=GND,INA2 input 20KHZ PWM		94		ns
fall time Input A to	tf	Signal. OUTA2 connects 100 ohm load to GND		19		
output A same direction signal	trr	INB2=GND,INA2 input 20KHZ PWM		111		ns
Delay	tff	Signal. OUTA2 connects 100 ohm load to GND		43		
Input A to output B reverse signal	trf	INB2=5V, INA2 inputs 20KHZ PWM signal		42		ns
Delay	tfr	Number. OUTB2 connects 100 ohm load to 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 table above.

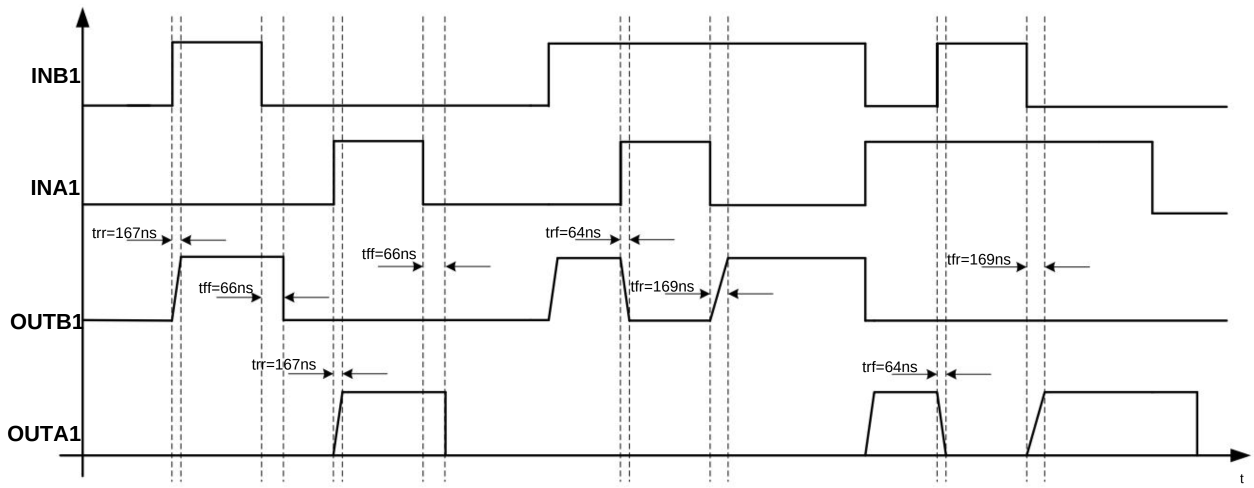
2. The delay of the reverse signal from input B to output A is the same as the delay of the reverse signal from input A to output B in the table above.

3. x represents 1 or 2.

Test schematic

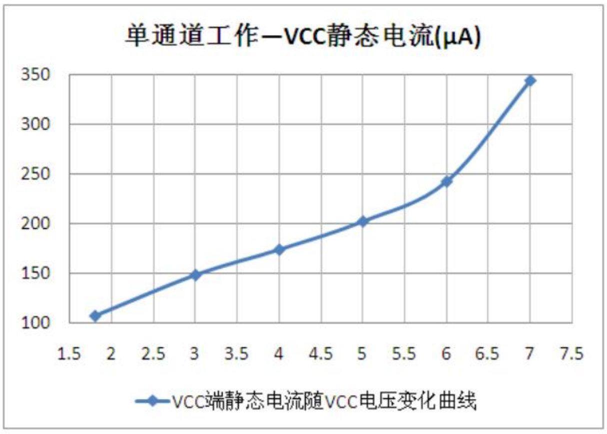


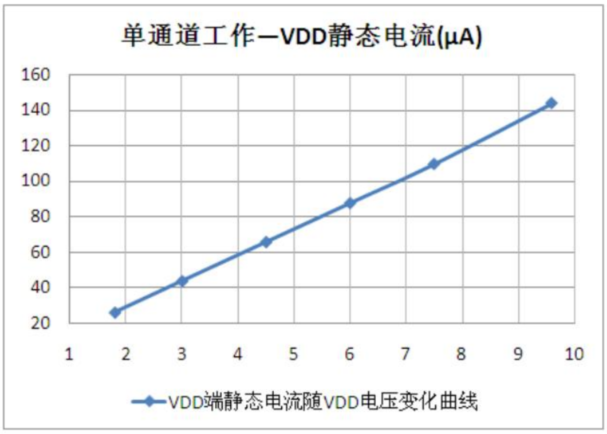
Time parameter test schematic diagram

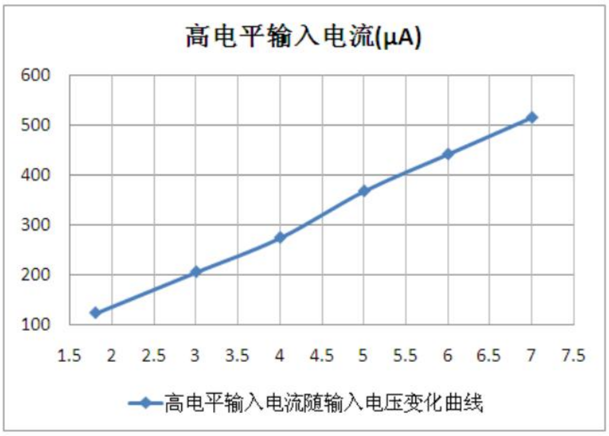


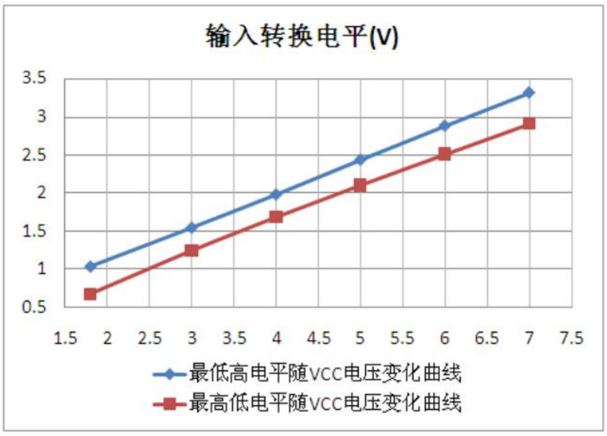
Time parameter definition

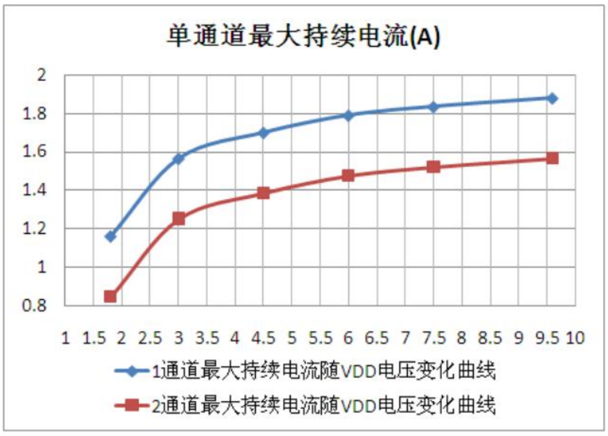
Electrical Characteristics Curve

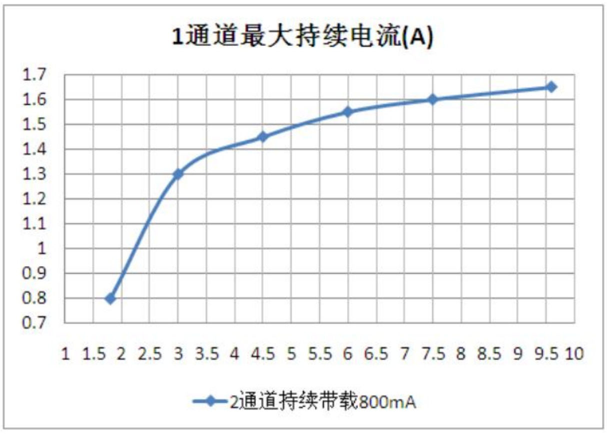


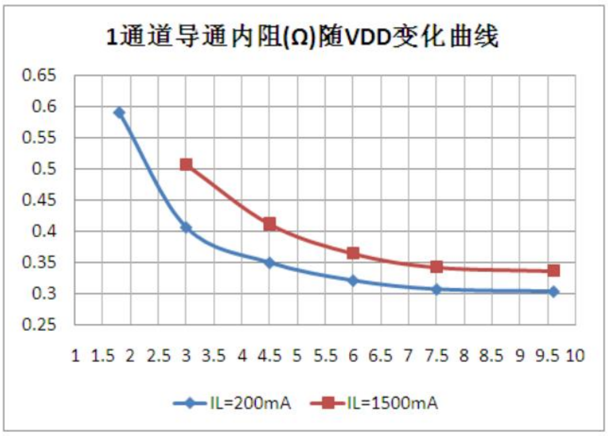


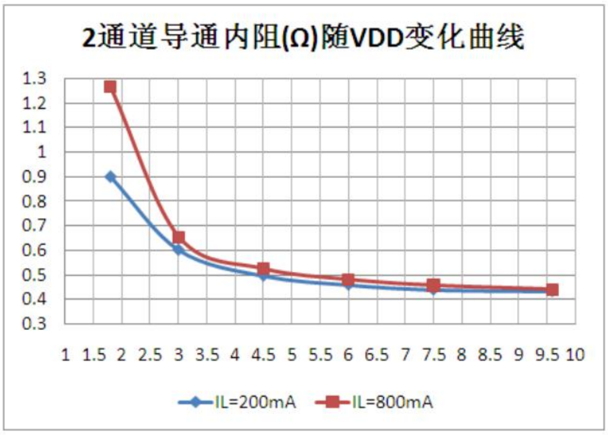












Typical application circuit diagram

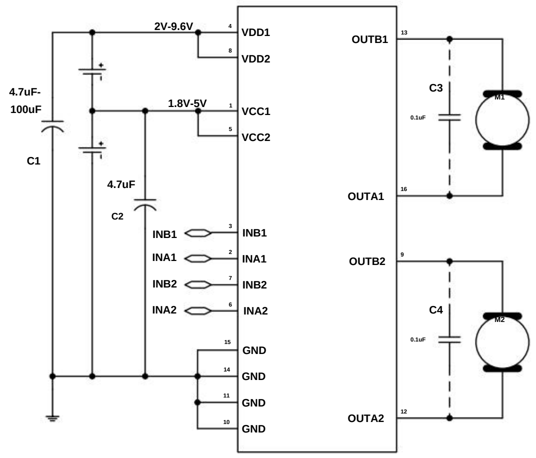


Figure 1 MX1508 typical application circuit diagram

special attention items:

Capacitor C1 in Figure 1 is the decoupling capacitor between the power supply and the ground. The capacitance of capacitor C1 during application can vary depending on the application conditions.

There are different options, as detailed below:

A. Under application conditions where the VDDx voltage is less than 7.2V (4 new dry batteries) and the peak current does not exceed 1.5A, capacitor C1 can be omitted.

B. Under application conditions where the VDDx voltage is between 7.2V-9.6V and the peak current exceeds 1.5A, capacitor C1 cannot be omitted and needs to be adjusted according to actual conditions.

In the case of the motor, the value of capacitor C1 is chosen between 47uF-100uF.

C. The type of capacitor C1 is not limited, it 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 applications, there is no need to add a separate capacitor close to the chip.

Shared with other control chips (RX2, MCU), etc. If VCCx does not have any capacitance to ground, when the circuit enters overheating protection mode due to overload, the circuit

Roads may go into lockdown. After entering the locked state, the state of the input signal must be changed again before the circuit can return to normal. if only

If VCCx has more than 4.7uF capacitance to 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 both ends of the motor and do not need to be separated separately.

Add to.

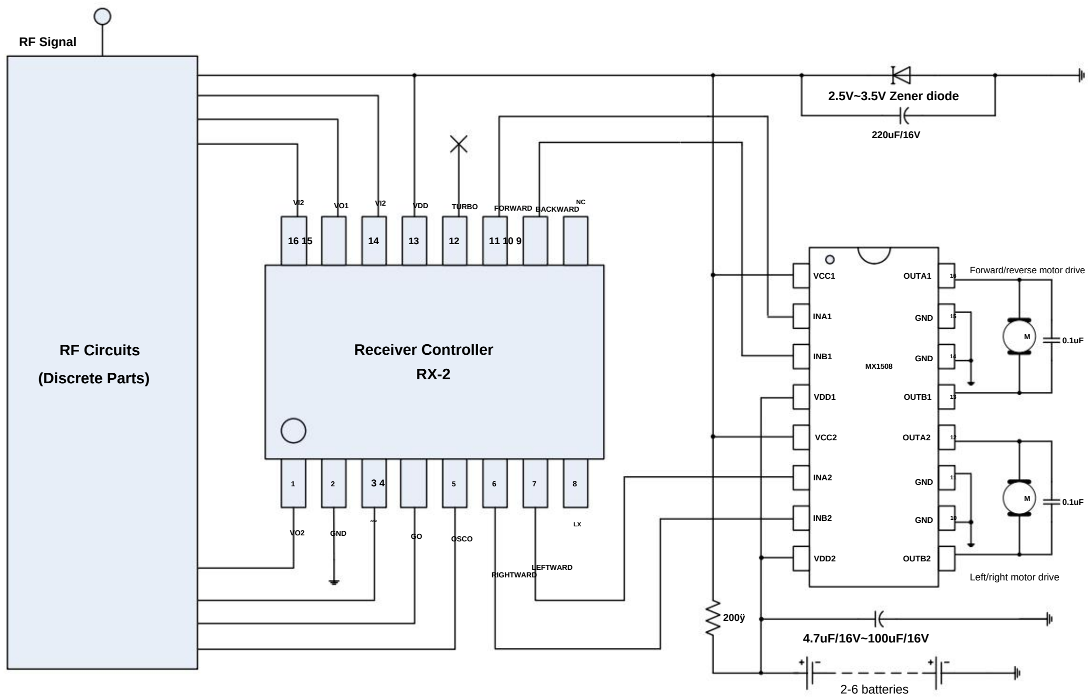


Figure 2 2-6 battery powered toy remote control car motor drive application circuit diagram

As shown in the motor drive application circuit diagram in Figure 2, the steering wheel drive current is small, and the 2-channel drive of MX1508 can be selected. The motor drive current is large, and the 1-channel drive of MX1508 can be selected.

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

VCCx and VDDx must be wired separately. VCCx only accepts static voltages within 5V and must share the 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 drive power tube, are off. Very low circuit consumption low current. At this time, both the motor output terminals OUTAx and OUTBx are in a high-impedance state.

b) Forward rotation mode

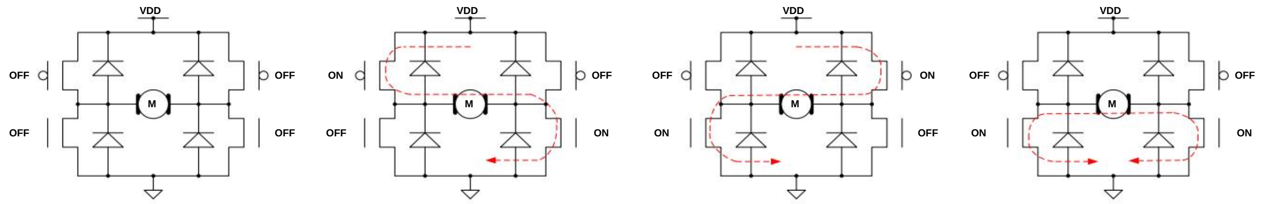
The definition of forward mode is: INAx=H, INBx=L. At this time, the motor drive terminal OUTAx outputs high level and the motor drive terminal OUTBx outputs low level. When the voltage level is high, the motor drive current flows from OUTAx into the motor and from OUTBx to the ground. At this time,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

c) Reversal mode

The definition of reversal mode is: INAx=L, INBx=H. At this time, the motor driving terminal OUTBx outputs high level and the motor driving terminal OUTAx outputs low level. When the voltage level is high, the motor drive current flows from OUTBx to 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 braking 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 stores The energy will be quickly released through the OUTAx terminal NMOS tube or the OUTBx terminal NMOS, and the motor will stop rotating in a short time. Pay attention to the brake The circuit will consume static power in car mode.

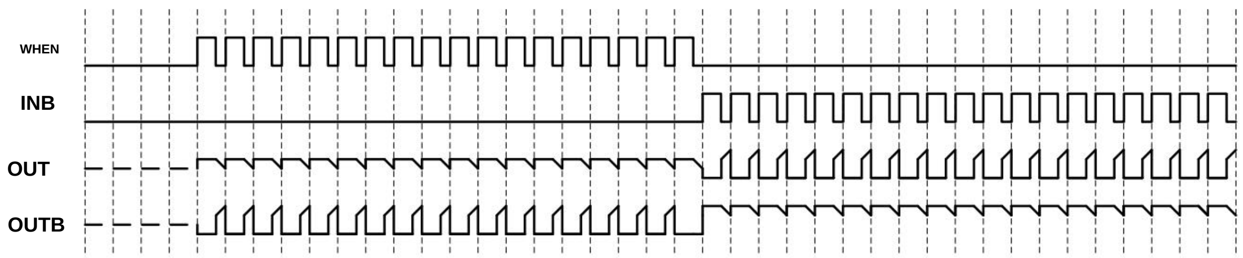


a) Standby mode b) Forward rotation mode c) Reversal mode d) Braking mode

e)PWM mode **A**

When the input signal INAx is a PWM signal, INBx=0 or INAx=0, and INBx is a PWM signal, the rotation speed of the motor will be affected by the PWM signal. Control of signal duty cycle. In this mode, the motor drive circuit is switched between conduction and standby modes. In standby mode, all functions The rate transistors are all in the off state, and the energy stored inside the motor can only be slowly released 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 If the frequency of the PWM signal is too high, the motor may not start.



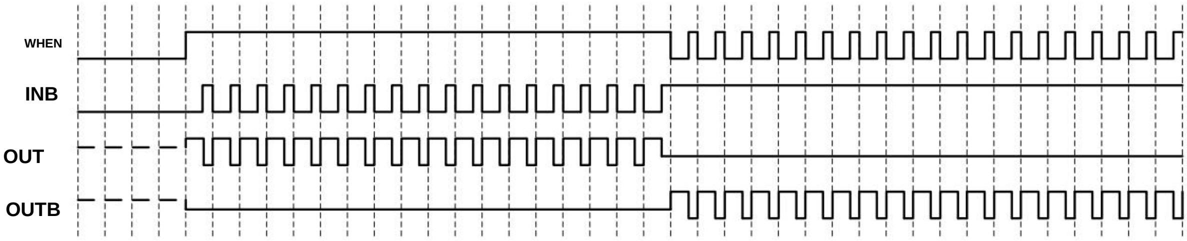
PWM mode A signal waveform diagram

f)PWM mode **B**

When the input signal INAx is a PWM signal, INBx=1 or INAx=1, and INBx is a PWM signal, the rotation speed of the motor will be affected by the PWM signal. Control of signal duty cycle. In this mode, the motor drive circuit output is between conduction and braking modes. In braking mode, the motor stores Energy is quickly released through the low-side NMOS transistor.

Note: Since there is a braking state in the working state, the motor energy can be released quickly, and the motor speed can be accurately determined by the duty cycle of the PWM signal. Accurate control, but it must be noted that if the PWM signal frequency is too low, the motor will not be able to rotate smoothly due to entering the braking mode.

In order 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 transistor and the low-side NMOS power transistor in the half-bridge are turned on at the same time is called the common mode conduction state. Common-mode conduction will cause a large transient current from the power supply to the ground, which will cause additional power loss and, in extreme cases, burn the circuit. Common-mode conduction is avoided through built-in dead time. Typical dead time is 300ns. 3. Overheating protection circuit When the drive circuit junction temperature exceeds the preset temperature (typical value is 150°C), the TSD circuit starts to work.

At this time, the control circuit forcibly turns off all output power tubes, and the drive 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 the preset temperature (typical value 130°C), the circuit returns to the normal operating state. 4. Maximum continuous power consumption of the drive circuit

This series of motor drive circuits are designed with overheating protection circuits. Therefore, when the power consumption of the drive circuit is too large, the circuit will enter the thermal state. Shutdown mode, the motor will not work properly in 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 working (ÿ), and ÿJ A is the circuit's Thermal resistance from junction to environment (unit: °C/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 conduction internal resistance. 5. Power consumption of the drive circuit. 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 of the drive circuit power consumption is: PD=IL , where IL represents the output current of the motor drive circuit, and RON represents the on- ^{2} xRON

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

the on-resistance must be considered when calculating the maximum continuous output current and power consumption of the circuit. 6. Maximum continuous output current of the drive circuit

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

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

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

continuous output current of the drive circuit is related to factors such as ambient temperature, packaging form, heat dissipation design, and on-resistance of the power MOSFET. 7. Selection of motor internal resistance 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 extremely small, and its locked-rotor 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, and the toy car is running or running. Jitter will occur when repeatedly moving forward and backward. When selecting a motor drive circuit, the internal resistance of the motor must be considered. Note: x represents 1 or 2.

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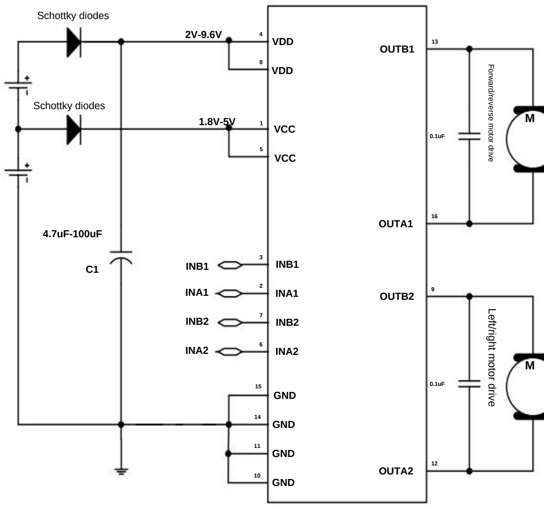
special attention items

1. Reverse connection between power supply and ground

Reverse connection of the circuit's power supply and ground wire will cause damage to the circuit, and in severe cases, cause the plastic package to smoke. Consider adding a string to the power supply end of the circuit Connect two power Schottky diodes to the positive terminal of the battery to prevent circuit damage caused by reverse battery connection. Power Schottky diode's maximum 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. Power Schottky Diode 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 breakdown and cause burn.



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

The power supply VDD to ground decoupling capacitor C1 required by the drive circuit (refer to the application circuit diagram 1) mainly has two functions: 1), absorbing the motor The energy released to the power supply stabilizes the power supply voltage and prevents the circuit from breakdown due to overvoltage; 2) When starting the motor or switching between rapid forward and reverse rotation Instantaneously, the motor requires a large current to start quickly. Due to the response speed of the battery and the long connection lead, the instantaneous output is often not possible 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 the capacitor, the larger the capacitance value, the smaller the voltage fluctuation within the same period of time. Therefore, under high voltage and large current application conditions The recommended value of capacitor C1 below depends on the actual use of the motor. The recommended value of capacitor C1 is between 4.7uF-100uF.

3. Electrostatic protection

The input/output ports of the circuit use CMOS devices, which are sensitive to electrostatic discharge. Although it is designed with an electrostatic protection circuit, during transportation and packaging Anti-static measures should be taken during assembly, processing and storage, especially during processing.

4. The output is short-circuited to ground or the output terminal is short-circuited.

During normal operation, when the high-level output terminal of the circuit is short-circuited to the ground or there is a short-circuit between OUTAx and OUTBx, the circuit internal A huge current will pass through, resulting in huge power consumption, triggering the overheating shutdown circuit inside the circuit, thereby protecting the circuit from immediate burnout. But because The overheating protection circuit only detects the temperature and does not detect the transient current passing through the circuit. When the output is short-circuited to ground, the current is extremely large, which can easily cause damage to the circuit. When using, avoid output short circuit to ground. Adding current limiting measures during testing can avoid similar damage.

5. The output is short-circuited to the power supply.

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

6. Motor stalled

During normal operation, when the load motor of the drive circuit is blocked, if the locked-rotor current exceeds the maximum continuous current of the drive circuit, current, the drive circuit will enter overheating protection mode to prevent circuit damage. However, if the locked-rotor current is much larger than the maximum peak current, the circuit will be easily damaged. bad.

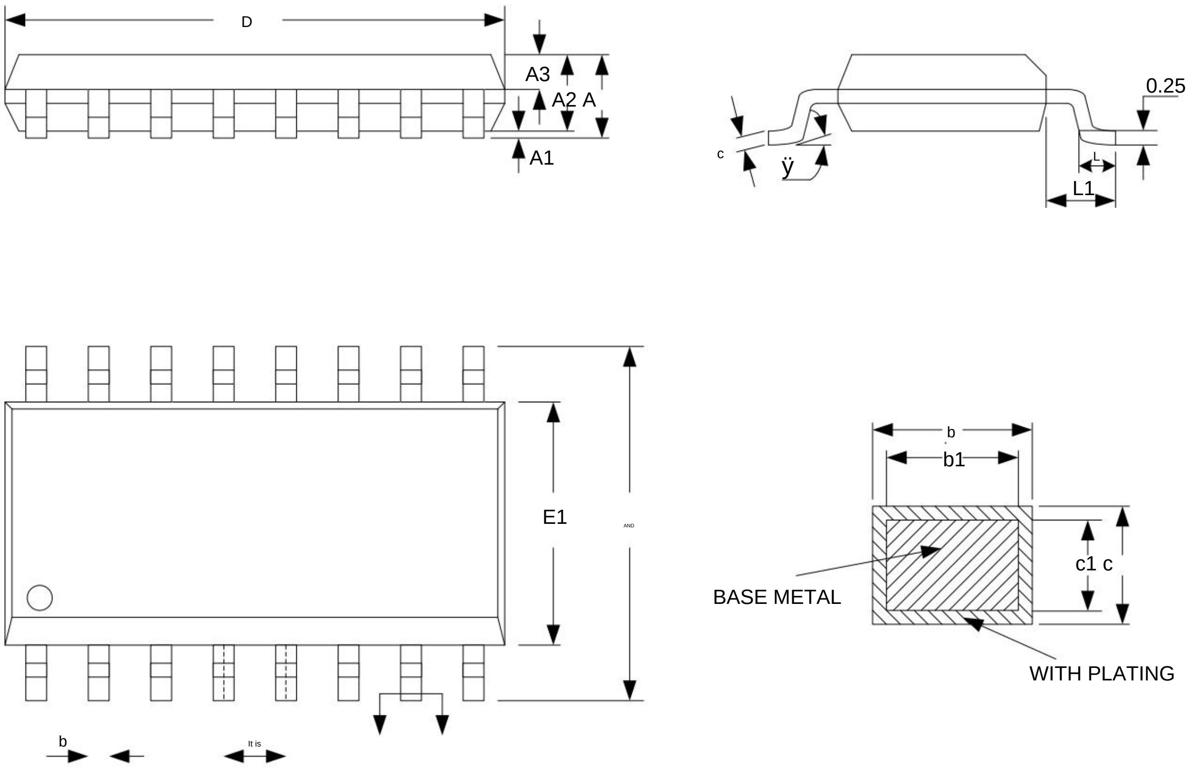
7. The peak current greatly exceeds the rated value

When the maximum operating voltage is close to or exceeds and the peak current greatly exceeds the absolute maximum peak current, the chip will also be burned.

Note: x represents 1 or 2.

Package dimensions drawing

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
It is	1.27BSC		
L	0.5	0.65	0.80
L1	1.05BSC		
ÿ	0°	-	8°

Version history

V1.0 initial version

V1.1 modifies the application conditions of the circuit and adds specific regulations on the power supply to ground decoupling capacitor.

V1.2 adds special provisions for VCC and VDD power-on

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