Dual brushed DC motor drive circuit

MX1208

Overview This product provides an integrated dual brushed DC motor driver for battery powered toys, low voltage or battery powered motion control applications. solution. The circuit integrates two channels of H-bridge drive circuits designed using N-channel and P-channel power MOSFETs, which are suitable for driving electric toys. Equipped with steering wheel and rear wheel drive. This circuit has a wide operating voltage range (from 2V to 9.6V), and the maximum continuous output voltage of the steering wheel drive is current reaches 0.8A, the maximum peak output current reaches 1.5A, the rear-wheel drive maximum continuous output current reaches 1.2A, and the maximum peak output current reaches 1.5A.

This drive circuit has a built-in overheat protection circuit. When the load current passing through the drive circuit is much greater than the maximum continuous current of the circuit, the package heat dissipation energy force limit, the junction temperature of the chip inside the circuit will rise rapidly. Once it exceeds the set value (typical value 150ÿ), the internal circuit will immediately shut down the output power. rate tube, cut off the load current, and avoid safety hazards such as smoke and fire in the plastic package caused by continued temperature rise. Built-in temperature hysteresis circuit ensures Only after ensuring that the circuit returns to a safe temperature can the circuit be controlled again.

Features

- Low standby current (less than 0.1uA);
- Low quiescent operating current;
- Integrated H-bridge drive circuit;
- Built-in anti-common state conduction circuit;
- Low on-resistance power MOSFET tube;
- Built-in overheat protection circuit (TSD) with hysteresis effect;
- Antistatic level: 3KV (HBM).

Typical

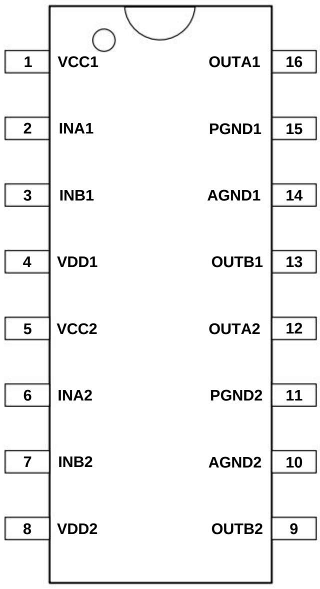
applications • Toy motor drive powered by 2-6 AA/AAA dry batteries;

- 2-6-cell nickel-hydrogen/nickel-cadmium rechargeable battery-powered toy motor drive;
- Motor drive powered by 1-2 lithium batteries

Ordering Information

Product number	encapsulation	Operating temperature
MX1208	SOP16	-20ÿ~85ÿ

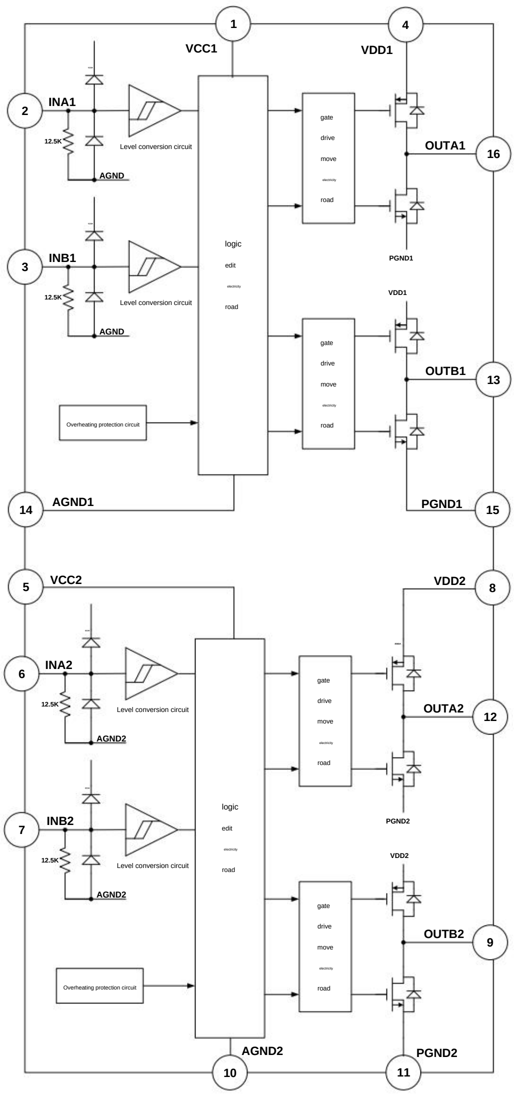
Pinout



Pin definition

Pin Number	Pin Name	Input/Output	Pin Function Description
1	VCC1	-	1 channel logic control power supply terminal
2	INA1	I	1 channel forward logic input
3	INB1	I	1 channel inverted logic input
4	VDD1	-	1 channel power supply terminal
5	VCC2	-	2-channel logic control power supply terminal
6	INA2	I	2-channel forward logic input
7	INB2	I	2 channel logic input
8	VDD2	-	2 channel power supply terminal
9	OUTB2	O	2 channel inverted output
10	AGND2	-	2-channel logic control circuit ground terminal
11	PGND2	-	2-channel output power tube ground terminal
12	OUTA2	O	2-channel forward output
13	OUTB1	O	1 channel inverted output
14	AGND1	-	1 channel logic control circuit ground terminal
15	PGND1	-	1 channel output power tube ground terminal
16	OUTA1	O	1 channel forward output

Functional block diagram

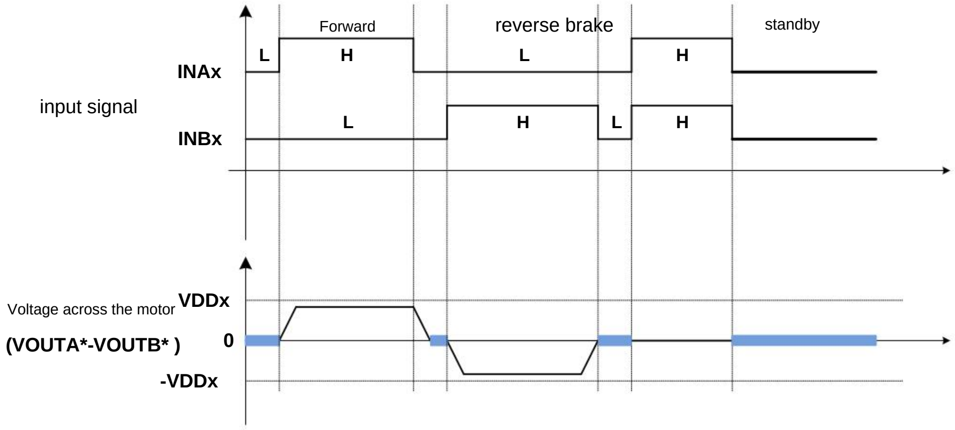


logical truth table

INAx	INBx	OUTAx	OUTBx	Function:
L	L	Z	Z	standby,
H	L	H	L	forward
L	H	L	H	rotation,
H	H	L	L	reverse rotation, 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 power	VCCx(MAX)	7	V
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	A
2 channel		2	
Maximum power	PD	1.5	W
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	Txt	-55~+150	ÿ
temperature Soldering temperature	TLED	260ÿ, 10 seconds	
ESD (Note		3000	V

3) 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 =I2xR

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

	Symbol	Minimum value	Typical value (VDD=6.5V)	Maximum value	Unit
(TA=25ÿ) Parameters Logic	VCCx	1.8	--	5	V
and control Power	VDDx	2	--	9.6	V
supply voltage Power supply voltage 2 Channel not working 1 Channel			1.35		A
continuous current IOUT1 1 Channel not working 2 Channel continuous			1.35		
current IOUT2 Channel 1 continuous output 0.6A 2 Channel continuous			1.3		
current IOUT2 Channel 1 continuous Output 0.8A 2-channel continuous			1.2		

current IOUT2 Note: (1), x represents 1 or 2.

(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.

Electrical Characteristics Parameter Table

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

	Symbol	Condition	Minimum value	Typical value	Maximum value	Unit
Parameters Power Parameters						
VCCx standby current	IVCCST	INA=INBx= L;VCCx=7V;	--	0	10	uA
VDDx standby current	IVDDST	VDDx=10V; output floating	--	0	10	
VCCx Quiescent supply current	IVCC	INAx=H OR INBx=H; output floating	--	182	--	uA
VDDx quiescent supply current	IVDD	INAx=H OR INBx=H; output floating input logic	--	83	--	
level						
Input high level	VINH		2	--	--	V
input low level input	VINL		--	--	0.8	
level hysteresis input	VHY			0.6		
high level current input pull-	IINH	VINH=2.5V,VCCx=3V		191		uA
down resistor power	RIN	VINH=3V,VCCx=3V		12		Kÿ
tube conduction internal resistance						
1 channel conduction internal resistance	RON1	IO=±200mA VDD1=6V TA=25ÿ		0.49		ÿ
		IO=±800mA VDD1=6V TA=25ÿ		0.53		
2 channel conduction internal resistance	RON2	IO=±200mA VDD2=6V TA=25ÿ		0.49		
		IO=±800mA VDD2=6V TA=25ÿ		0.53		
Protection function parameters						
Thermal shutdown	TSD		--	150	--	ÿ
temperature point Thermal	TSDH		--	20	--	
shutdown temperature hysteresis power **MOSFET** body diode conduction characteristics-1 channel						
PMOS body diode	VPD	I=400mA,VCC1=3V, VDD1=INA1=INB1=0V		0.76		V
NMOS body diode	VND	I=-400mA, VCC1=VDD1=3V, INA1=INB1=0V		0.75		
Power **MOSFET** body diode conduction characteristics - 2 channels						
PMOS body diode	VPD	I=400mA,VCC2=3V, VDD2=INA2=INB2=0V		0.76		V
NMOS body diode	VND	I=-400mA, VCC2=VDD2=3V, INA2=INB2=0V		0.75		
Motor drive time parameter-1 channel						
Output rise time	tr	INB1=H,INA1 input pulse signal		300		ns
Output fall time	tf	The signal duty cycle is 50%		10		
Output delay time	trf	The signal frequency is 20KHz		40		
Output delay time	tfr	The internal resistance of the load motor is 1.3ÿ, and the motor is idling.		240		
Motor drive time parameters - 2 channels						
Output rise time,	tr	INB2=H,INA2 input pulse signal		300		ns
output fall time,	tf	The signal duty cycle is 50%		10		
output delay time,	trf	The signal frequency is 20KHz		40		
output delay time	tfr	The internal resistance of the load motor is 1.3ÿ, and the motor is idling.		240		

Note: x represents 1 or 2.

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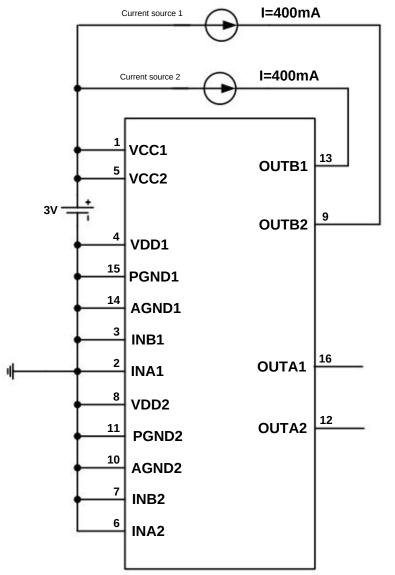
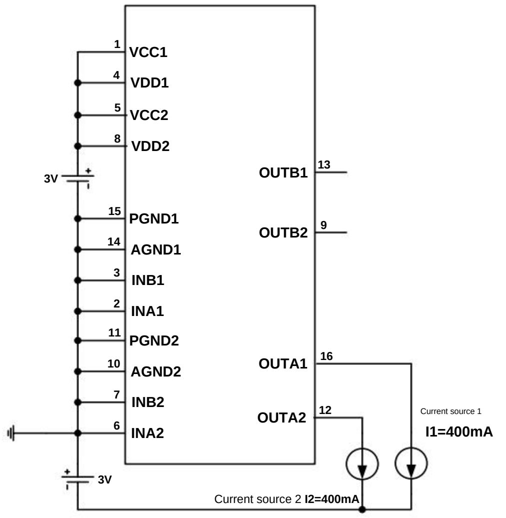
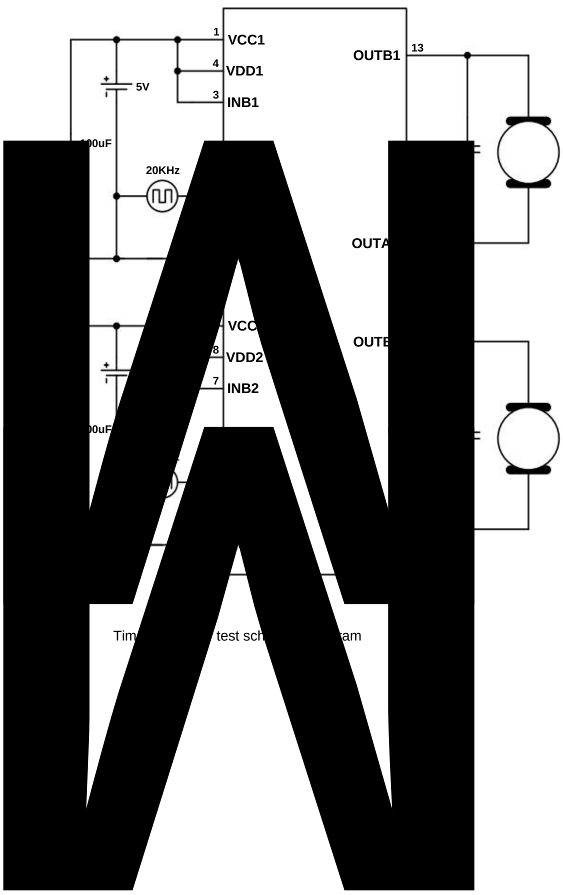
Test schematic



PMOS body diode conduction voltage test schematic diagram



NMOS body diode conduction voltage test schematic diagram



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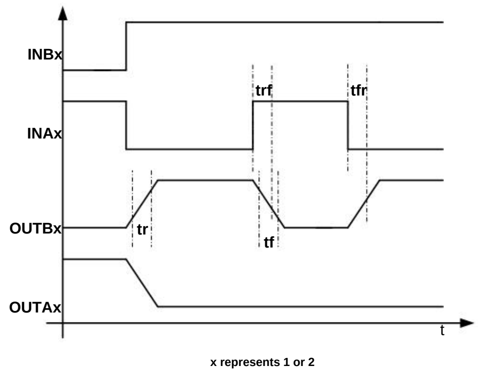
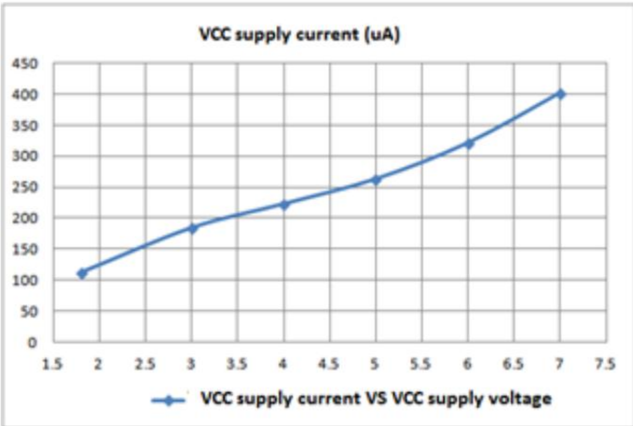
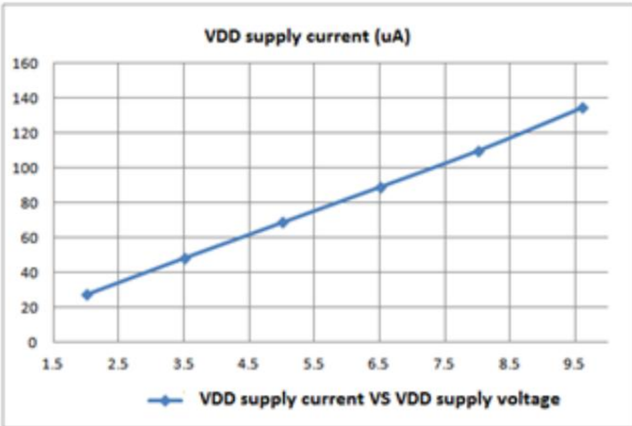
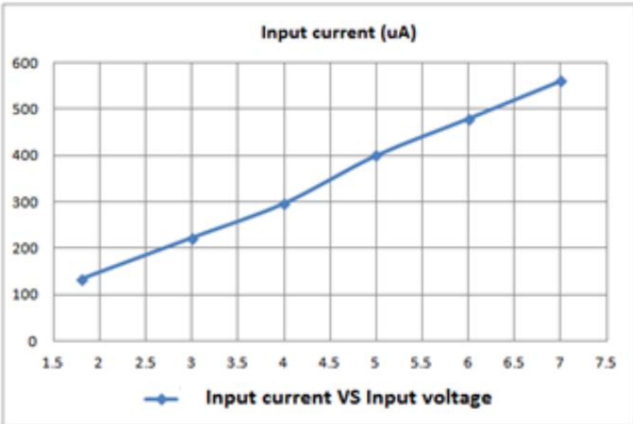


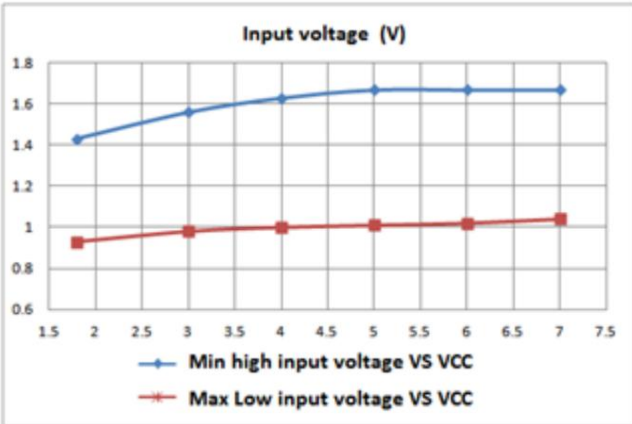
Time parameter definition

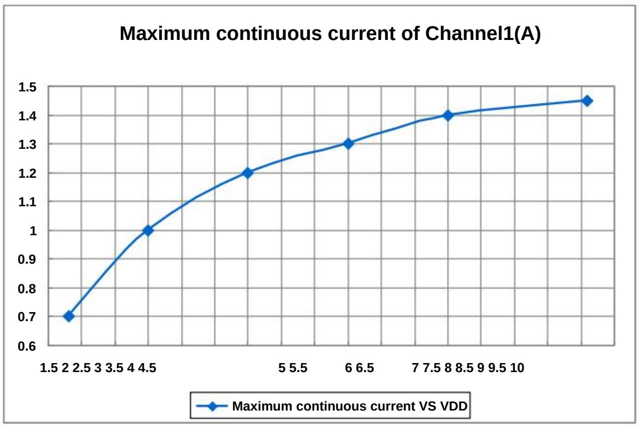
Electrical characteristic curve

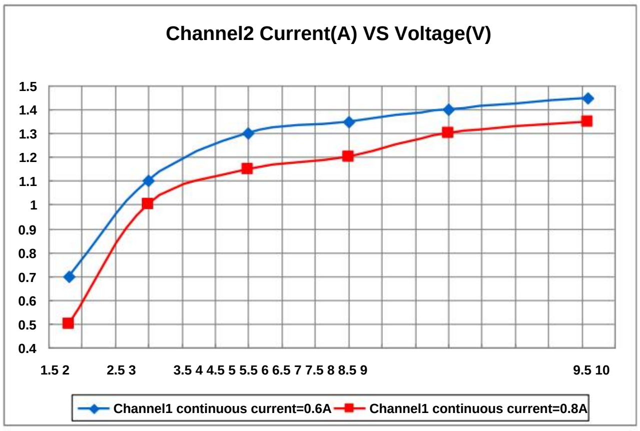


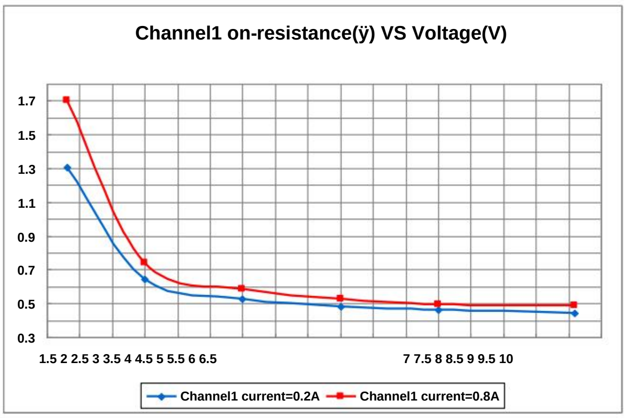












Typical application circuit diagram

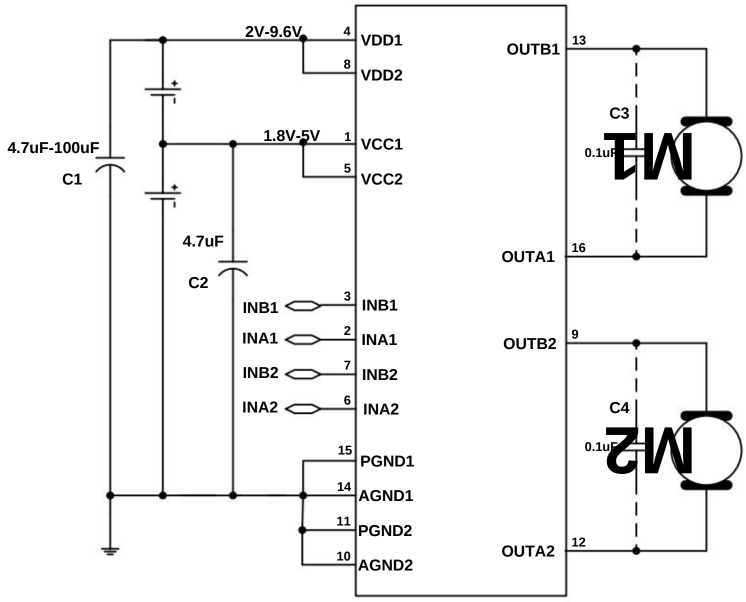


Figure 1 MX1208 typical application circuit diagram

special attention items:

The value of the power supply VDD to ground decoupling capacitor (C1) in Figure 1 should be adjusted according to the specific application. The higher the VDD voltage, the higher the output peak current. Larger, the larger the value of C1, but the value of capacitor C1 needs to be at least 4.7uF. Under high voltage and large current application conditions, it is recommended that the value of capacitor C1 be 100uF.

The logic power supply VCC 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. It can be combined with Shared with other control chips (RX2, MCU), etc. If VCC does not have any capacitance to ground, when the circuit enters overheating protection mode due to overload, 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. As long as VCC If there is 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 (x=1,2) in Figure 1 represent the capacitors connected to both ends of the motor and are not required. Added separately.

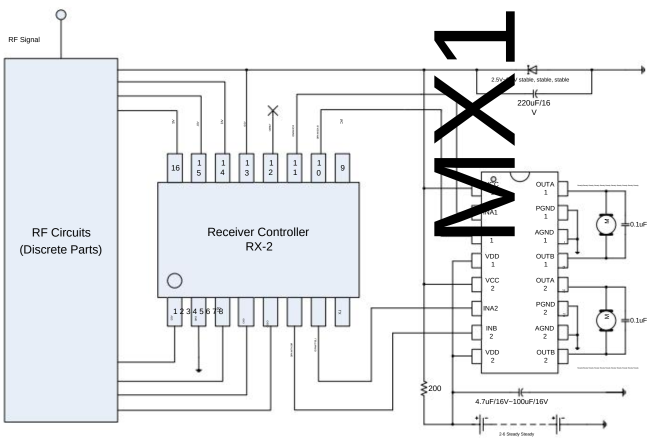


Figure 2 2-6 battery powered toy remote control car motor drive application circuit diagram

As shown in Figure 2, the motor drive application circuit diagram, in which the steering wheel drive current is small, you can choose the 2-channel drive of MX1208, and the rear wheel motor If the driving current is larger, you can choose the 1-channel driver of MX1208. The decoupling capacitors of VDD1 and VDD2 to ground in Figure 2 should be determined according to actual usage conditions. Select the capacity value. The higher the voltages of VDD1 and VDD2, the greater the motor current and the greater the capacitance value. The capacitor must be greater than 4.7uF.

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.

Normally, 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 forward rotation mode.

c) Reversal mode

The definition of reversal mode is: INAx=L, INBx=H. At this time, the motor drive terminal OUTBx outputs high level and the motor drive terminal OUTAx outputs low level.

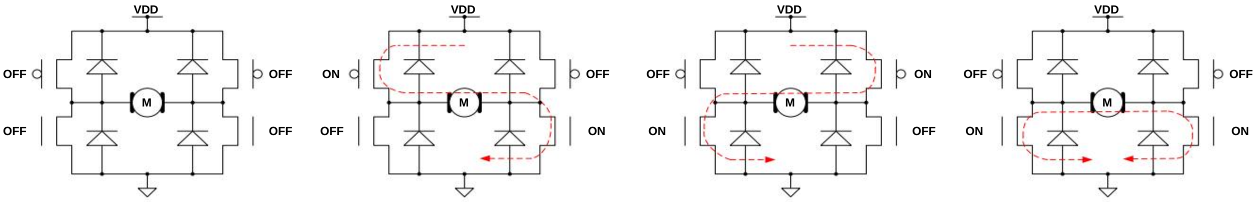
Normally, the motor drive current flows from OUTBx to the motor and from OUTAx to the ground. At this time, the rotation of the motor is defined as reverse rotation mode.

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

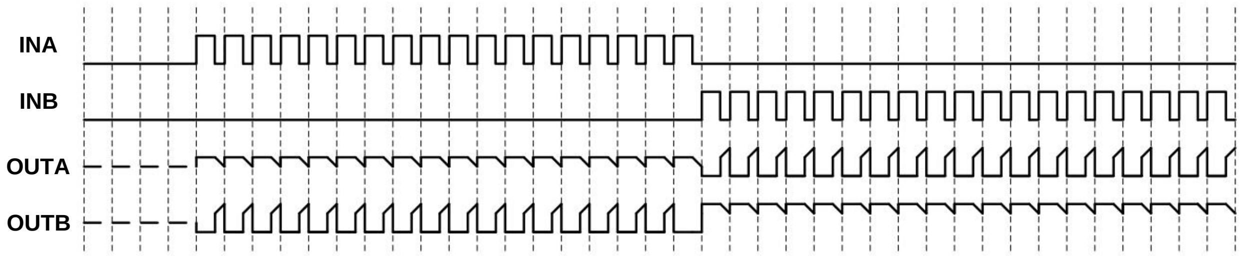
the input signal INAx is a PWM signal, INBx=0 or INAx=0, and INBx is a PWM signal, the rotation speed of the motor will be affected by the PWM signal.

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 PWM

If the frequency of the 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.

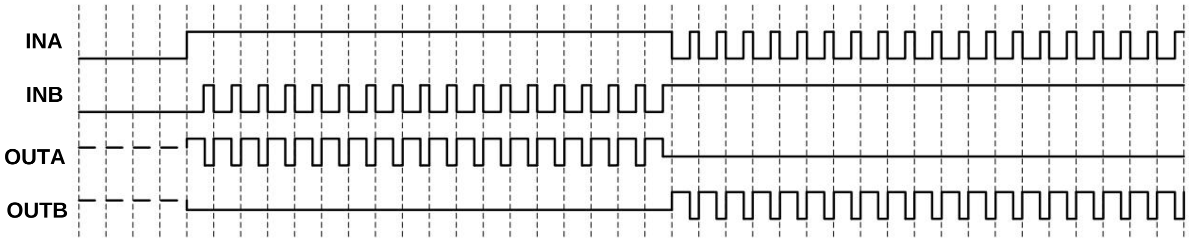
Control of signal duty cycle. In this mode, the motor drive circuit output is between conduction and braking modes. In braking mode, the motor stores

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 state 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-state 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 inside. Therefore, when the power consumption of the drive circuit is too large, the circuit will enter thermal shutdown.

shutdown mode, the motor will not work properly 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 working (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 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. Calculation formula for drive circuit power consumption

is: PD=IL 2 xRON

Among them , 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. 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: Error! No reference

source found. RONT is the on-state internal 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

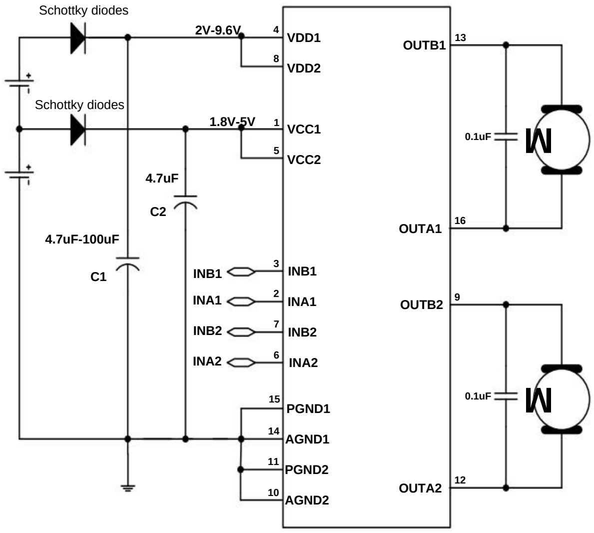
internal resistance The above

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, its locked-rotor circuit 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, and the toy car will vibrate when running or 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.

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 connecting in series at the power end of the circuit Two power Schottky diodes are connected 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 VDD1, VDD2 to ground decoupling capacitor (C1)

The drive circuit requires the addition of power supplies VDD1, VDD2 and ground decoupling capacitor C1 (refer to application circuit diagram 1), which have 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 requires an instantaneous high current to start quickly. Due to the response speed of the battery and the long connecting leads, it is often not possible to That is, to output a transient large current, 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 the application conditions of high voltage and large current It is recommended that the value of capacitor C1 be 100uF. It is recommended that the capacitor value be selected according to the specific application, but the value of capacitor C1 needs to be at least 4.7uF.

3. Electrostatic protection

The input/output ports of the circuit use CMOS devices, which are sensitive to electrostatic discharge. Although the design is equipped with electrostatic protection circuits, during transportation, packaging, Anti-static measures should be taken during 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 stalled current exceeds the maximum continuous current of the drive circuit, 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.

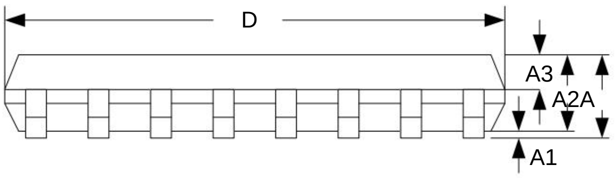
7. The peak current greatly exceeds the rated value

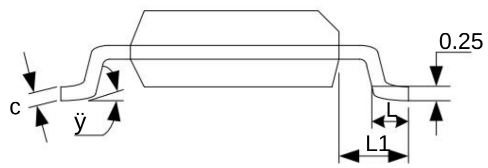
When the maximum operating voltage is close to or exceeds and the peak current greatly exceeds the absolute maximum peak current, the chip will also be burned.

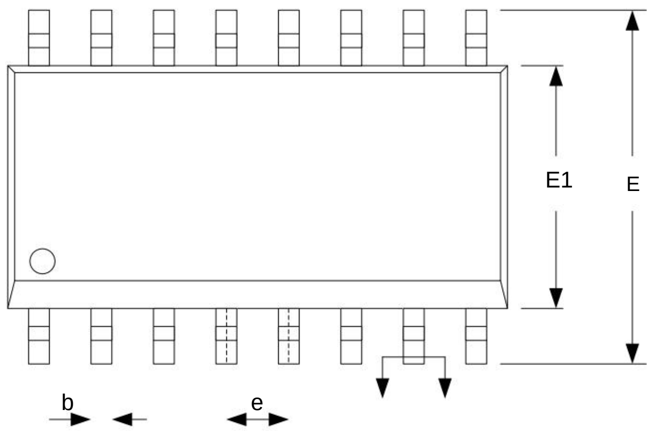
Note: x represents 1 or 2.

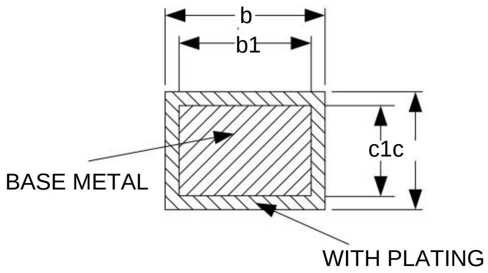
Package dimensions drawing

SOP16:









SYMBOL	MILLMETER		
	MIN	NOM	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
E	5.80	6.00	6.20
E1	3.70	3.90	4.10
e	1.27BSC		
L	0.5	0.65	0.80
L1	1.05BSC		
ÿ	0°	-	8°

Version history

V1.0 initial version