

双路有刷直流马达驱动电路 / Brushed DC motor drive circuit

MX1208

概述 / Overview

该产品为电池供电的玩具、低压或者电池供电的运动控制应用提供了一种集成的双路有刷直流马达驱动解决方案。

This product provides an integrated dual brushed DC motor drive solution for battery-powered toys, low-voltage or battery-powered motion control applications.

电路内部集成了两通道采用 N 沟和 P 沟功率 MOSFET 设计的 H 桥驱动电路，适合于驱动电动玩具车的转向轮及后轮驱动。

Integrated in the circuit are two-channel H-bridge drive circuits designed with N-channel and P-channel power MOSFETs, suitable for driving steering wheels and rear wheels of electric toy cars.

该电路具备较宽的工作电压范围（从 2V 到 9.6V），转向轮驱动最大持续输出电流达到 0.8A，最大峰值输出电流达到 1.5A，后轮驱动最大持续输出电流达到 1.2A，最大峰值输出电流达到 1.5A。

The circuit has a wide operating voltage range (from 2V to 9.6V), the maximum continuous output current of the steering wheel drive reaches 0.8A, and the maximum peak output current reaches 1.5A, the maximum continuous output current of rear wheel drive reaches 1.2A, and the maximum peak output current reaches 1.5A.

该驱动电路内置过热保护电路。通过驱动电路的负载电流远大于电路的最大持续电流时，受封装散热能力限制，电路内部芯片的结温将会迅速升高，一旦超过设定值（典型值 150° C），内部电路将立即关断输出功率管，切断负载电流，避免温度持续升高造成塑料封装冒烟、起火等安全隐患。

This driving circuit has built-in overheating protection circuit. When the load current of the driving circuit is far greater than the maximum continuous current of the circuit, the junction temperature of the chip inside the circuit will rise rapidly due to the heat dissipation capacity of the package. Once it exceeds the set value (typically 150 ° C), the internal circuit will Turn off the output power tube, cut off the load current, and avoid the safety hazards such as smoke and fire caused by the continuous increase in temperature caused by the plastic package.

内置的温度迟滞电路，确保电路恢复到安全温度后，才允许重新对电路进行控制。

The built-in temperature hysteresis circuit ensures that the circuit can be controlled again after it has returned to a safe temperature.

特性

- 低待机电流（小于 0.1uA）；
- 低静态工作电流；
- 集成的 H 桥驱动电路；
- 内置防共态导通电路；
- 低导通内阻的功率 MOSFET 管；
- 内置带迟滞效应的过热保护电路（TSD）；
- 抗静电等级：3kV（HBM）。

Characteristics

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

典型应用

- 2-6 节 AA/AAA 干电池供电的玩具马达驱动；
- 2-6 节镍-氢/镍-镉充电电池供电的玩具马达驱动；
- 1-2 节锂电池供电的马达驱动

typical application

- 2-6 AA / AAA dry battery powered toy motor drives;
- Toy motor powered by 2-6 Ni-MH / Ni-Cd rechargeable batteries;
- Motor driven by 1-2 lithium batteries

订购信息

产品型号	封装	工作温度 / Operating temperature
MX1208	SOP16	-20℃ ~ 85℃

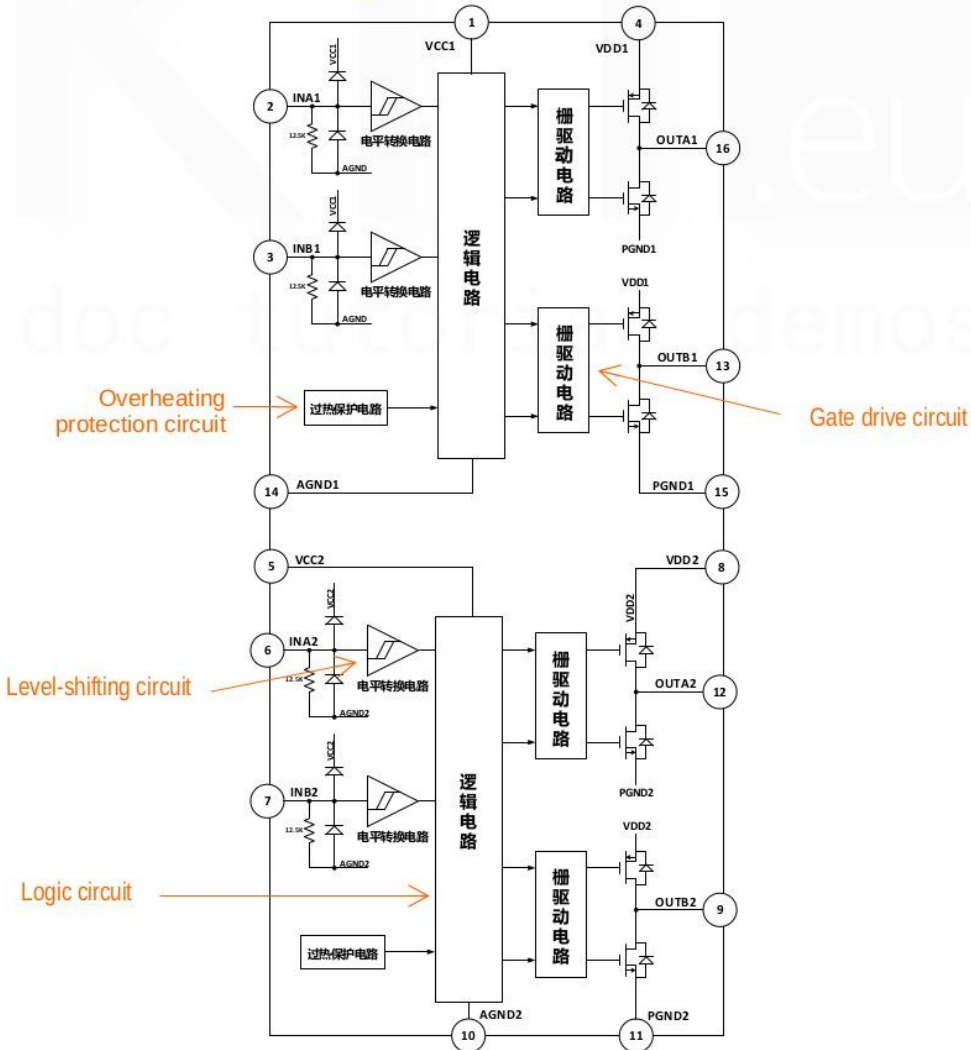
引脚排列



引脚定义

引脚编号	引脚名称	输入 / 输出	引脚功能描述
1	VCC1	-	Channel 1 logic control power supply
2	INA1	I	Channel 1 forward logic input
3	INB1	I	Channel 1 inversion logic input
4	VDD1	-	Channel 1 motor power supply
5	VCC2	-	2 通道逻辑控制电源端
6	INA2	I	2 通道正转逻辑输入
7	INB2	I	2 通道逻辑输入
8	VDD2	-	2 通道功率电源端
9	OUTB2	O	Channel 2 inversion output
10	AGND2	-	Channel 2 logic control circuit ground
11	PGND2	-	Channel 2 output power ground
12	OUTA2	O	Channel 2 forward output
13	OUTB1	O	1 通道反转输出
14	AGND1	-	1 通道逻辑控制电路接地端
15	PGND1	-	1 通道输出功率管接地端
16	OUTA1	O	1 通道正转输出

功能框图 / Functional Block Diagram

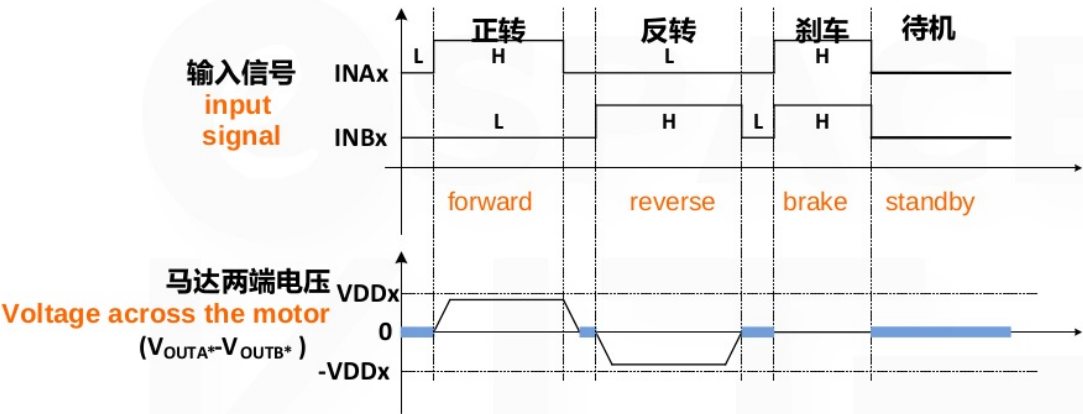


逻辑真值表 / Logical truth table

INAx	INBx	OUTAx	OUTBx	功能 / Features
L	L	Z	Z	待机 / Standby
H	L	H	L	正转 / Forward
L	H	L	H	反转 / Reverse
H	H	L	L	刹车 / brake

注：x 代表 1 或者 2。

典型波形示意图 / Typical waveform diagram



注：x 代表 1 或者 2。

绝对最大额定值(T_A=25°C) Absolute Maximum Rating (T_A=25°C)

参数 / parameter	符号	值	单位
最大逻辑控制电源电压 / Max. logic supply voltage	VCCx(MAX)	7	V
最大功率电源电压 / Max. power supply voltage	VDDx(MAX)	10	
最大外加输出端电压 / Max. external output voltage	VOUT(MAX)	VDD	
最大外加输入电压 / Max. logic input voltage	VIN(MAX)	VCC	
最大峰值输出电流 Peak output current	1 通道 / Channel 1	2	A
	2 通道 / Channel 2	2	
最大功耗 / Maximum power consumption	P _D	1.5	W
结到环境热阻 Junction-to-ambient thermal resistance	SOP16 封装 package θ _{JAD}	80	°C/W
工作温度范围 / range of working temperature	T _{opr}	-20~+85	°C
结温 / Junction temperature	T _J	150	°C
储存温度 / Storage temperature	T _{stg}	-55~+150	°C
焊接温度 / Welding temperature	T _{LED}	260°C , 10 秒	
ESD(注 3) / ESD (see note 3)		3000	V

注：(1)、×代表1或者2。

(2)、不同环境温度下的最大功耗计算公式为：

The formula for calculating the maximum power consumption at different ambient temperatures is

T_A表示电路工作的环境温度， θ_{JA}为封装的热阻。 150°C表示电路的最高工作结温。
T_A: the ambient temperature at which the circuit operates. θ_{JA}: is the thermal resistance of the package. 150°C: is the maximum operating junction temperature of the circuit.

$$P_D = (150^\circ\text{C} - T_A) / \theta_{JA}$$

(3)、电路功耗的计算方法：

Calculation method of circuit power consumption :

$$P = I^2 \times R$$

其中 P 为电路功耗，I 为持续输出电流 R 为电路的导通内阻。电路功耗 P 必须小于最大功耗 P_D

P: circuit power I: continuous output current, R: is the on-resistance of the circuit.

The circuit power P must be less than the maximum power P_D.

(4)、人体模型，100pF 电容通过 1.5KΩ 电阻放电。

Human body model, 100pF capacitor is discharged through 1.5kOhms resistor.

推荐工作条件(T_A=25°C) Recommended working conditions

MAX

参数 / Parameter	符号	最小值 / MIN	典型值 / typical (VDD = 6.5V)	最大值	单位
逻辑和控制电源电压 / Logic and control supply voltage	VCCx	1.8	--	5	V
功率电源电压 / Power supply voltage	VDDx	2	--	9.6	V
2 通道不工作 / CH2 off	1 通道持续电流 / CH1	I _{OUT1}	1.35		A
1 通道不工作 / CH1 off	2 通道持续电流 / CH2	I _{OUT2}	1.35		
通道 1 持续输出 0.6A	2 通道持续电流 / CH2	I _{OUT2}	1.3		
通道 1 持续输出 0.8A	2 通道持续电流 / CH2	I _{OUT2}	1.2		

when channel 1 at 0.8A ; when channel 1 at 0.6A continuous current

注：(1)、×代表1或者2。

(2)、逻辑控制电源 VCC 与功率电源 VDD 内部完全独立，可分别供电。当逻辑控制电源 VCC 掉电之后，电路将进入待机模式。

The logic control power VCC is completely independent from the power power VDD, and can be powered separately. When the logic control power VCC is powered down, the circuit will enter standby mode.

(3)、持续输出电流测试条件为：电路贴装在 PCB 上测试，SOP16 封装的测试 PCB 板尺寸为 21mmx19mm。

The continuous output current test conditions are: the circuit is mounted on the PCB to test, and the test PCB size of the SOP16 package is 21mmx19mm

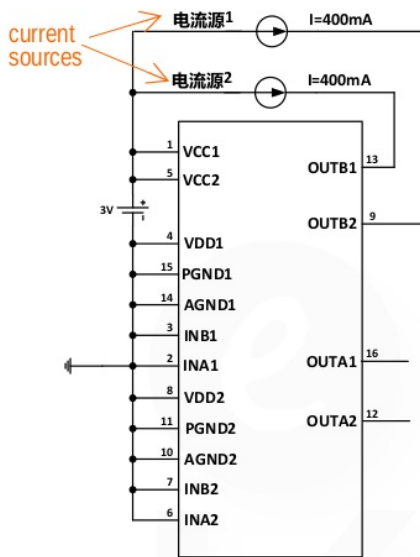
电特性参数表 / Electrical characteristics parameter table

(TA=25℃, VCCx=3V, VDDx=6V 除非另有规定 / Unless otherwise specified)

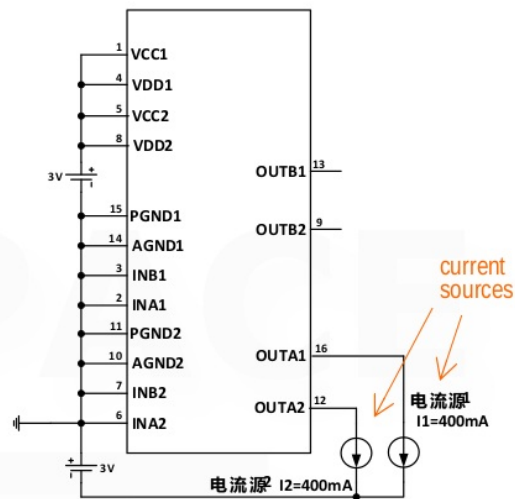
参数 / parameter	符号	条件 / condition	最小值 min. value	典型值 typical	最大值 max. value	单位
电源参数 / Power parameter						
VCCx 待机电流 standby current	I _{VCCST}	INA=INBx= L; VCCx=7V;	--	0	10	uA
VDDx 待机电流	I _{VDDST}	VDDx=10V; 输出悬空 / output is floating	--	0	10	
VCCx 静态电源电流 Quiescent supply current	I _{VCC}	INAx=H or INBx=H; 输出悬空	--	182	--	uA
VDDx 静态电源电流	I _{VDD}	INAx=H or INBx=H; 输出悬空	--	83	--	
输入逻辑电平 / Input logic level						
输入高电平 / High level	V _{INH}		2	--	--	V
输入低电平 / Low level	V _{INL}		--	--	0.8	
输入电平迟滞 / hysteresis	V _{HYS}			0.6		
输入高电平电流 / High current	I _{INH}	V _{INH} =2.5V, VCCx=3V		191		uA
输入下拉电阻 / Pull down	R _{IN}	V _{INH} =3V, VCCx=3V		12		KΩ
功率管导通内阻 / Internal resistance of power tube conduction						
1 通道导通内阻 Channel 1/2 conduction internal resistance	R _{ON1}	IO=±200mA VDD1=6V TA=25℃		0.49		Ω
		IO=±800mA VDD1=6V TA=25℃		0.53		
2 通道导通内阻	R _{ON2}	IO=±200mA VDD2=6V TA=25℃		0.49		
		IO=±800mA VDD2=6V TA=25℃		0.53		
保护功能参数 / Protection function parameters						
热关断温度点	TSD	Thermal shutdown temperature	--	150	--	℃
热关断温度迟滞	TSDH	Thermal shutdown temperature hysteresis	--	20	--	
功率 MOSFET 体二极管导通特性-1 通道 Channel 1's power MOSFET body diode conduction characteristics						
PMOS 体二极管 body diode	V _{PD}	I=400mA, VCC1=3V, VDD1=INA1=INB1=0V		0.76		V
NMOS 体二极管 body diode	V _{ND}	I=-400mA, VCC1=VDD1=3V, INA1=INB1=0V		0.75		
功率 MOSFET 体二极管导通特性-2 通道 Channel 2's power MOSFET body diode conduction characteristics						
PMOS 体二极管 body diode	V _{PD}	I=400mA, VCC2=3V, VDD2=INA2=INB2=0V		0.76		V
NMOS 体二极管 body diode	V _{ND}	I=-400mA, VCC2=VDD2=3V, INA2=INB2=0V		0.75		
电机驱动时间参数-1 通道 Channel 1's Motor drive time parameters						
输出上升时间 / Output rise time	t _r	INB1=H, INA1 = 输入脉冲信号 / input pulse signal		300		ns
输出下降时间 / fall time	t _f	信号占空比为 50% signal duty cycle		10		
输出延迟时间 Output delay time	t _{rf}	信号频率为 20KHz signal frequency		40		
输出延迟时间	t _{fr}	负载电机内阻 1.3Ω, 电机空转 motor internal resistance 1.3 Ohms, motor idling		240		
电机驱动时间参数-2 通道 Channel 2's Motor drive time parameters						
输出上升时间	t _r	INB2=H, INA2 输入脉冲信号		300		ns
输出下降时间	t _f	信号占空比为 50%		10		
输出延迟时间	t _{rf}	信号频率为 20KHz		40		
输出延迟时间	t _{fr}	负载电机内阻 1.3Ω, 电机空转		240		

注：x 代表 1 或者 2。

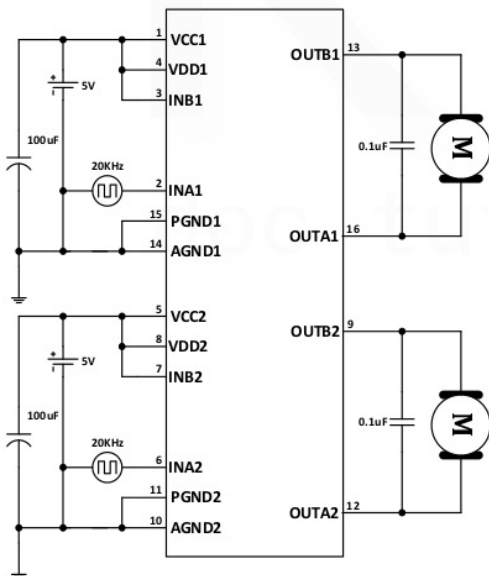
测试原理图 / Test schematic



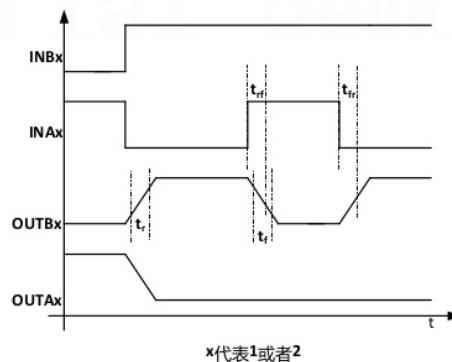
PMOS 体二极管导通电压测试原理图
PMOS body diode on-voltage test schematic



NMOS 体二极管导通电压测试原理图
NMOS body diode on-voltage test schematic

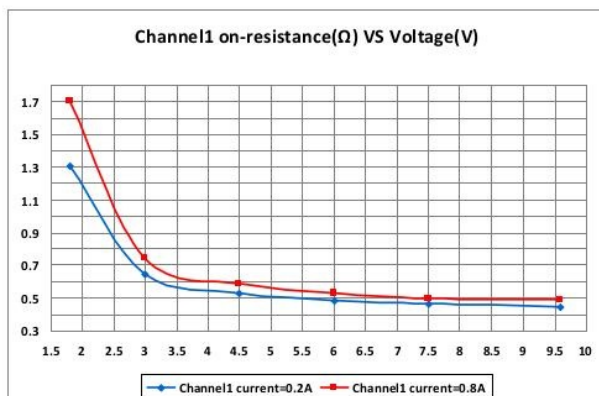
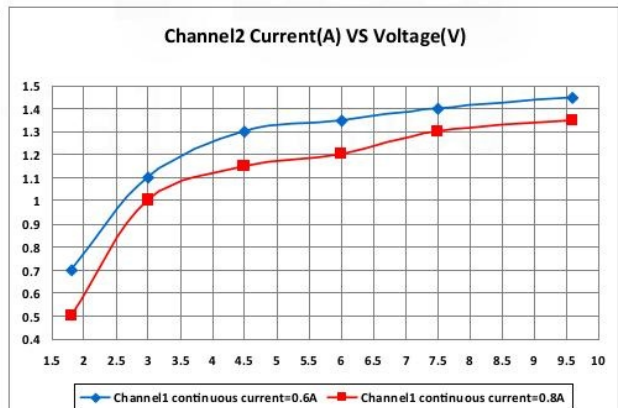
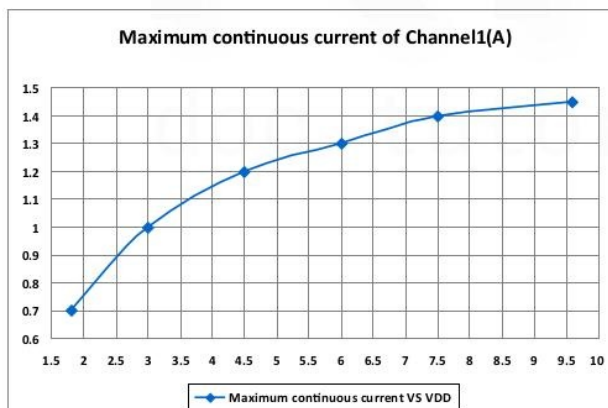
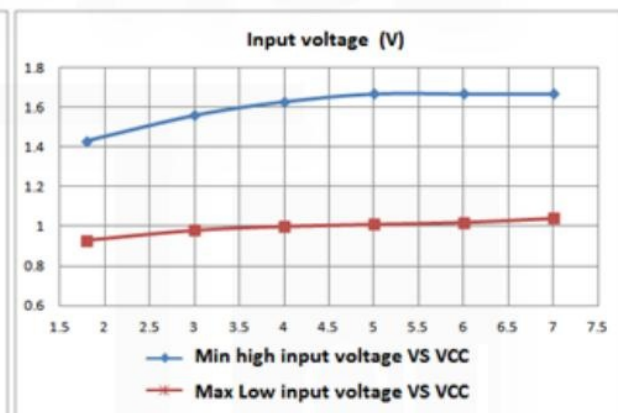
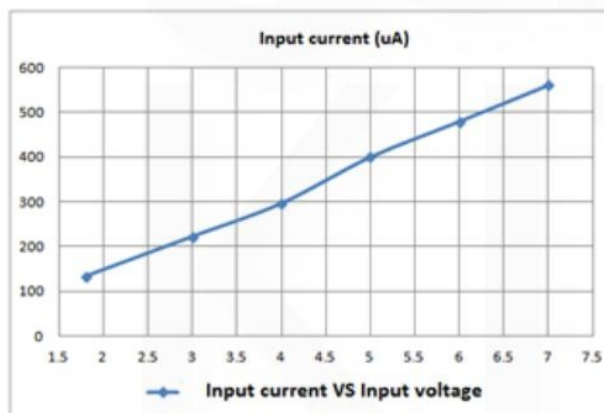
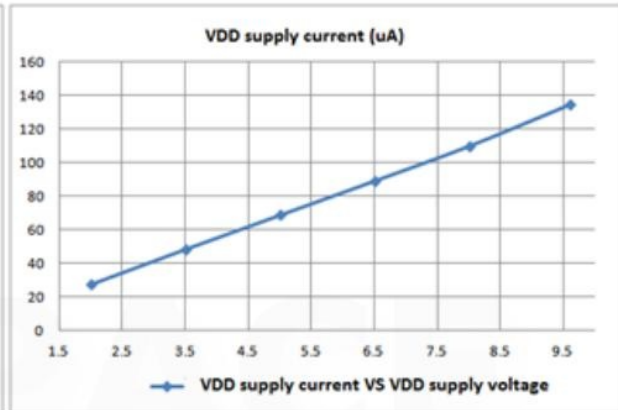
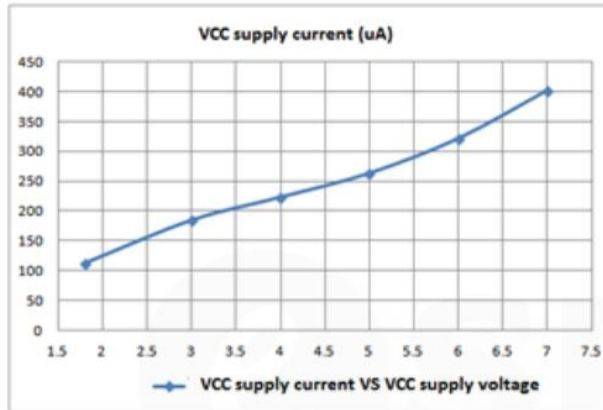


时间参数测试原理图
Time parameter test schematic diagram



时间参数定义
Time parameter definition

电特性曲线 / Electrical characteristic curve



典型应用线路图 / Typical application circuit diagram

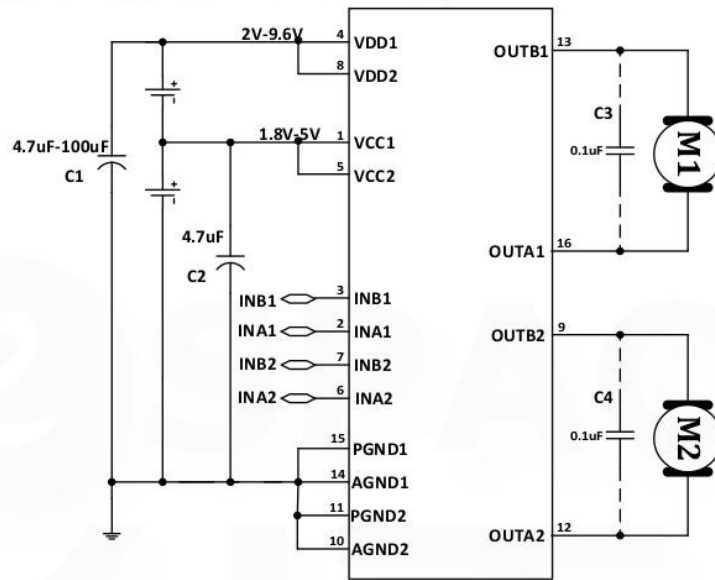


图 1 MX1208 典型应用线路图 / Typical application circuit diagram

特别注意事项：/ WARNINGS：

图 1 中的功率电源 VDD 对地去耦电容 (C1) 容值应根据具体的应用调整，VDD 电压越高，输出峰值电流越大，C1 取值越大，但是电容 C1 的取值至少需要 4.7uF。在高压、大电流的应用条件下建议电容 C1 取值 100uF。

逻辑电源 VCC 对地电容 C2 必须至少需要 4.7uF，实际用时不需要靠近芯片单独添加一个电容，可以和其它控制芯片 (RX2, MCU) 等共用。如果 VCC 对地没有任何电容，当电路因过载进入过热保护模式后，电路可能会进入锁定状态。进入锁定状态后，必须重新改变一次输入信号的状态，电路才能恢复正常。只要 VCC 对地有超过 4.7uF 电容，电路就不会出现锁定状态。

The power supply VDD to ground decoupling capacitor (C1) capacitance value should be adjusted according to the specific application. The higher the VDD voltage, the larger the output peak current, the larger the value of C1. However, the value of capacitor C1 needs to be at least 4.7uF. It is recommended that the value of capacitor C1 be 100uF under high voltage and high current application conditions.

The logic power VCC capacitor to ground C2 must be at least 4.7uF. In actual application, it is not necessary to add a separate capacitor near the chip, and it can be shared with other control chips (RX2, MCU). If VCC does not have any capacitor to ground, the circuit may enter the locked state when the circuit enters the thermal protection mode due to overload. After entering the locked state, the state of the input signal must be changed again for the circuit to return to normal. As long as VCC has more than 4.7uF capacitance to ground, the circuit will not lock up.

图 1 中驱动电路 OUTAx 与 OUTBx (x=1, 2) 之间的 0.1uF 电容 (C3, C4) 是表示接在马达两端的电容，不需要单独添加。

The 0.1uF capacitors (C3, C4) between the middle drive circuit OUTAx and OUTBx (x=1,2) are the capacitors connected across the motor, and do not need to be added separately.

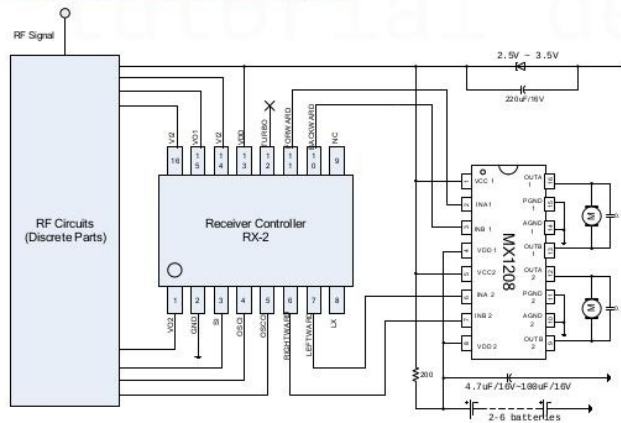


图 2 2-6 节电池供电玩具遥控车马达驱动应用线路图

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

如图 2 所示的马达驱动应用线路图，其中转向轮驱动电流较小，可选择 MX1208 的 2 通道驱动，后轮马达驱动电流较大，可选择 MX1208 的 1 通道驱动。

图 2 中的 VDD1, VDD2 对地去耦电容应根据实际使用情况选择容值。

VDD1, VCC2 电压越高，马达电流越大，电容容值越大。

电容必须大于 4.7uF。

The motor drive application circuit shown in Figure 2, where the steering wheel drive current is small, you can choose the MX1208 2-channel drive, the rear wheel motor drive current is large, you can choose the MX1208 1-channel drive.

The decoupling capacitors for VDD1 and VDD2 in Figure 2 should be selected based on actual usage.

The higher the VDD1, VCC2 voltage, the larger the motor current, and the larger the capacitance value. The capacitance must be greater than 4.7uF.