MD3901

Dual Full Bridge Low Voltage Motor Driver

Features and Benefits

- Low $R_{DS(on)}$ MOSFET output drivers
- Full- and half-stepping capability
- Low DC current
- Forward, reverse, and brake modes for dc motors
- Sleep mode with zero current drain
- PWM control up to 50 kHz
- Crossover-current protection
- Thermal shutdown (TSD)
- ESD protected: 3KV (HBM)

Description

The MD3901 is a dual full-bridge motor driver, designed for low voltage portable applications involving bipolar stepper or brush dc motors. The outputs have been optimized for low voltage drop, and an operating voltage range of 2V to 9.6V with currents up to ±1A (±2A with outputs paralleled).

The four inputs (IN1 to IN4) can control a bipolar stepper motor in full- or half-step mode, or dc motors in forward, reverse, or brake mode. The inputs can be at frequencies up to 50 kHz for PWM current or speed control.

Internal protection circuitry includes thermal shut down (TSD) and crossover (shoot-through) protection.

Typical Application

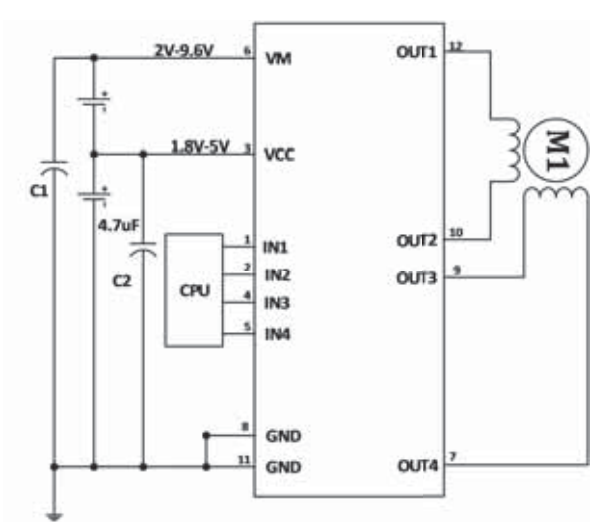


Figure 1. Typical stepper motor control

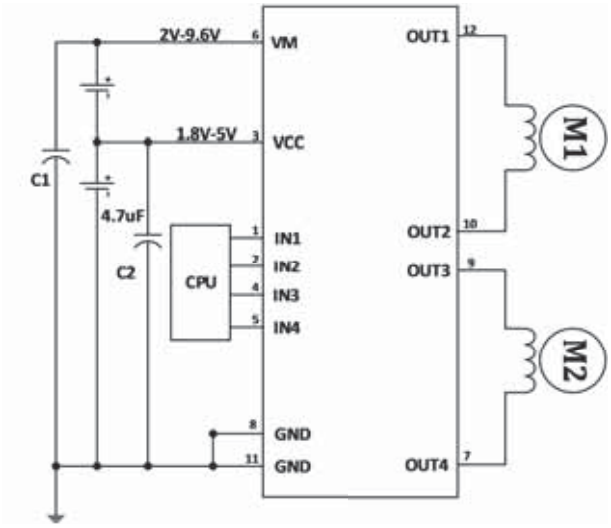


Figure 2. Typical dual dc motor control

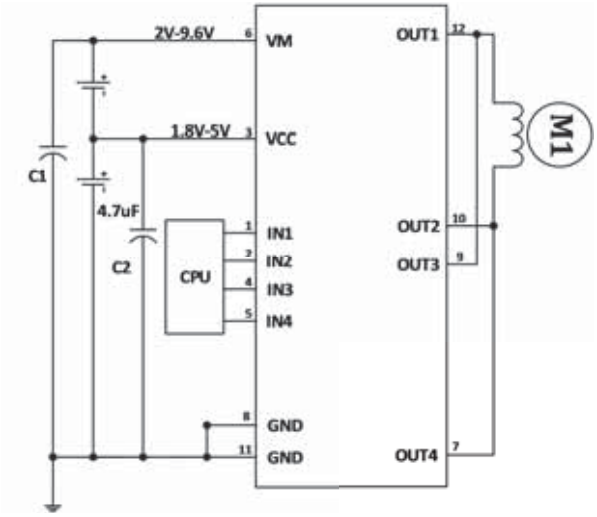
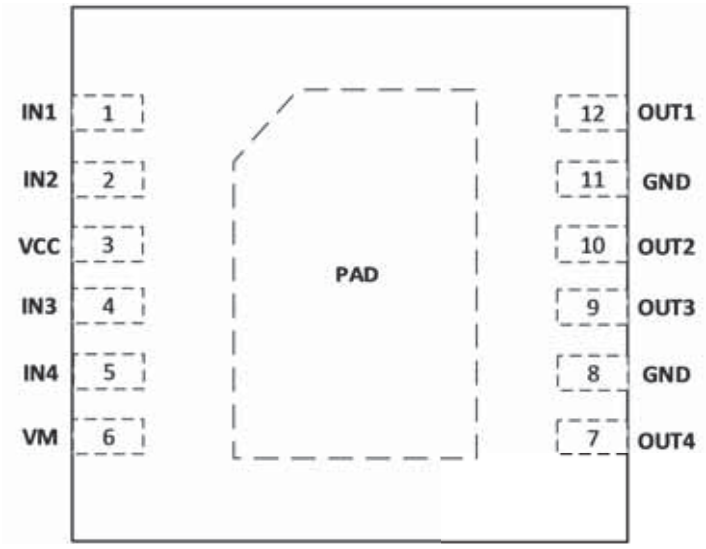


Figure 3. Typical single dc motor control (paralleled outputs)

Selection Guide

Order Number	Operating Temperature Range	Package	Marking Information	Transport Media, Quantity
MD3901	-20 to 85℃	DFN12	MD3901	Tape and Reel,3000

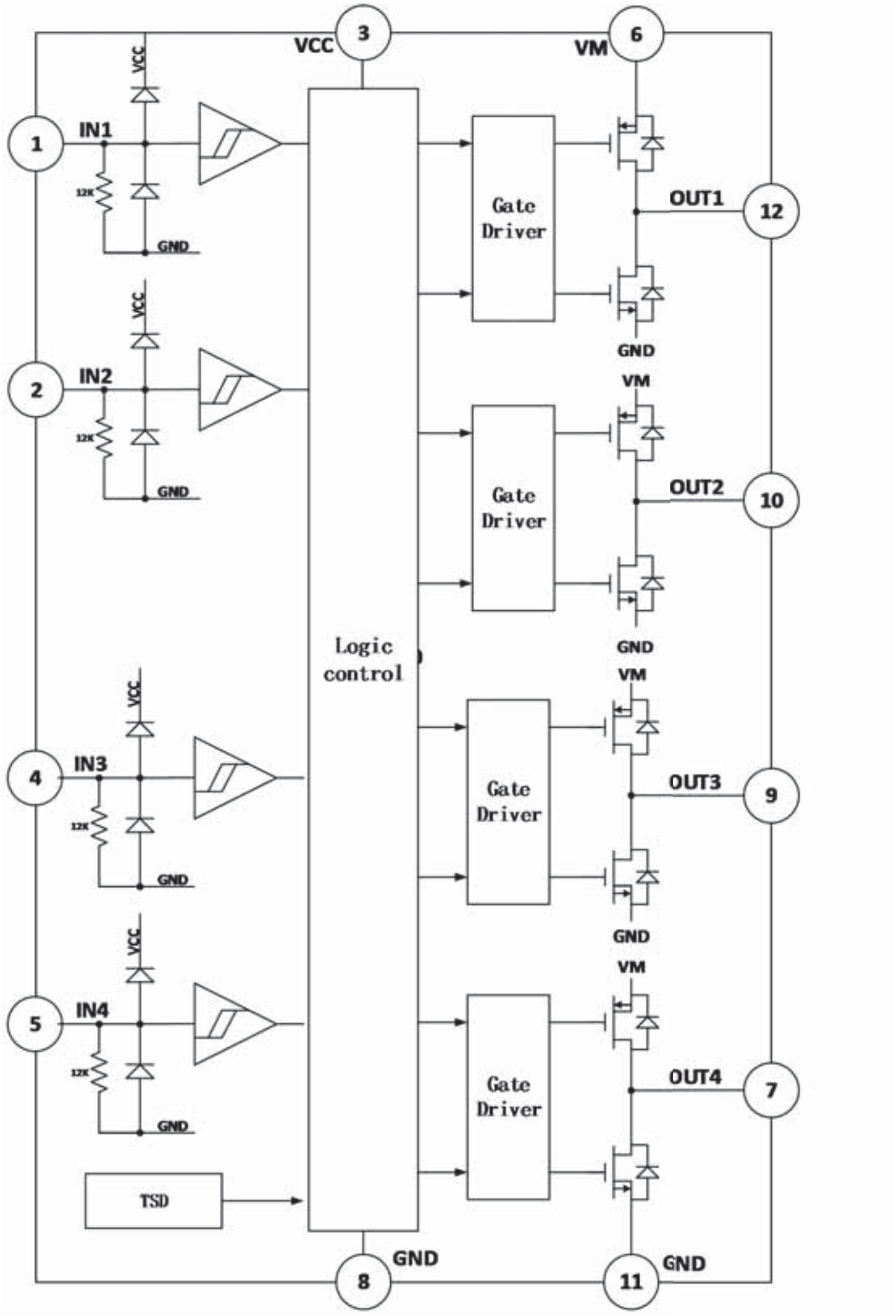
Package Diagram



Number	Name	I/O	Description
1	IN1	I	Line1 Logic input 1
2	IN2	I	Line1 Logic input 2
3	VCC	P	Logic power supply, not near connect with VM
4	IN3	I	Line2 Logic input 3
5	IN4	I	Line2 Logic input 4
6	VM	P	Load supply terminal
7	OUT4	O	Line 2 Bridge H output
8	GND	-	Ground terminal
9	OUT3	O	Line 2 Bridge H output
10	OUT2	O	Line 1 Bridge H output
11	GND	-	Ground terminal
12	OUT1	O	Line 1 Bridge H output

Remark：Logic power supply VCC can not be approached directly into the VM as VCC weak in Motor peak voltage resistance. Recommended by PCB line connected to the control IC power supply.

Functional Block Diagram



Motor Operation Truth Table

INx				OUT1	OUT2	OUT3	OUT4	Function	
Stepper Motor									
IN1	IN2	IN3	IN4					**Full Stepping**	**Half-Stepping**
0	0	0	0	OFF	OFF	OFF	OFF	Sleep Mode	Sleep Mode
1	0	1	0	H	L	H	L	Step1	Step1
0	0	1	0	OFF	OFF	H	L	-	Step2
0	1	1	0	L	H	H	L	Step2	Step3
0	1	0	0	L	H	OFF	OFF	-	Step4
0	1	0	1	L	H	L	H	Step3	Step5
0	0	0	1	OFF	OFF	L	H	-	Step6
1	0	0	1	H	L	L	H	Step4	Step7
1	0	0	0	H	L	OFF	OFF	-	Step8
DC Motor (Dual)									
IN1 or IN3		IN2 or IN4							
0		0		OFF	OFF	OFF	OFF	Hi-Z (Sleep Mode)/Coast	
1		0		H	L	H	L	Forward	
0		1		L	H	L	H	Reverse	
1		1		L	L	L	L	Brake	
DC Motor (Single, Paralleled)									
IN1 or IN3		IN2 or IN4							
0		0		OFF	OFF	OFF	OFF	Hi-Z (Sleep Mode)/Coast	
1		0		H	L	H	L	Forward	
0		1		L	H	L	H	Reverse	
1		1		L	L	L	L	Brake	
DC Motor (External PWM)									
IN1 or IN3		IN2 or IN4							
1 0		0 0		H OFF	L OFF	H OFF	L OFF	Forward Fast Decay	
0 0		1 0		L OFF	H OFF	L OFF	H OFF	Reverse Fast Decay	
1 1		0 1		H L	L L	H L	L L	Forward Slow Decay	
0 1		1 1		L L	H L	L L	H L	Reverse Slow Decay	

Absolute Maximum Ratings at T_A =25°C

Characteristics		Symbol	Typ.	Unit
Logic supply control Voltage		VCC(MAX)	7	V
Motor Driver Voltage		VM(MAX)	10	
Output Current per Channel		VOUT(MAX)	VM	
Logic Input Voltage Range		VIN(MAX)	VCC	
Peak Current output	Line 1	IOUT(PEAK)	1.5	A
	Line 2		1.5	
Maximum Power Dispation		P_D	--	W
Package Thermal Resistance	DFN12 Package	θ_{JAD}	--	℃/W
Operating Temperature Range		T_{opr}	-20~+85	℃
Junction Temperature		T_J	150	℃
Storage Temperature Range		Tstg	-55~+150	℃
Soldering Temperature		T_{LED}	260℃，10 seconds	
ESD(*3)			3000	V

Remark：(1)、Line1 represent as OUT1&OUT2，and line2 asOUT3&OUT4;

(2)、Maximum Power Dispation is $P_D=(150℃-T_A)/\theta_{JA}$ for different temperature.

T_A is instead of Operating Temperature, θ_{JA} is thermal resistance in package,150℃ is highest junction temperature.

(3)、The Current Power Dispation: $P=I^2xR$

And P is Power Dispation，I is continuous output current，R is on-state resistance. $P<P_D$

(4)、HM，100 pf capacitor discharge by 1.5 K Ω resistance.

Suggest Operation Condition(T_A=25℃)

Characteristics		Symbol	Min	Typ.(VM=6.5V)	Max	Unit
Logic supply control Voltage		VCC	1.8	--	5	V
Load Supply Voltage		VM	2	--	9.6	V
Line2 Sleep mode	Line1 continuous current	I_{OUT1}		1		A
Line1 Sleep mode	Line2 continuous current	I_{OUT2}		1		
Line1 continuous current=0.8A	Line2 continuous current	I_{OUT2}		0.8		

Remark：(1)、Line1 represent as OUT1&OUT2，and line2 asOUT3&OUT4;

(2)、VCC and VM inside circuit independent completely, and supply respectively. the circuit will be standby if VCC off line.

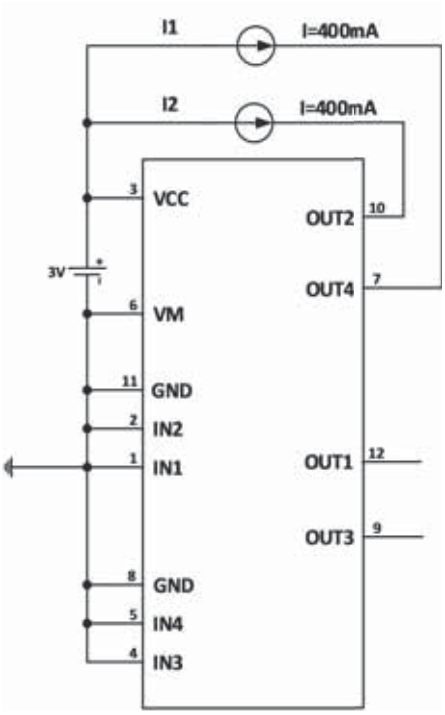
(3)、continuous output current test condition: Mount and PCB test .

ELECTRICAL CHARACTERISTICS at T_A =25°C, and V_{CC} = 3V,VM=6V, unless noted otherwise

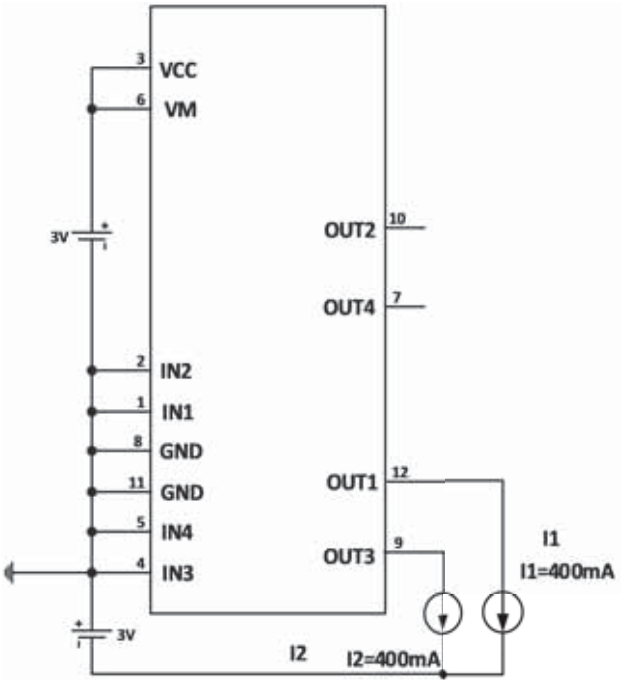
Characteristics	Symbol	Test Conditions	Min.	Typ.	Max.	Units
Motor Supply Parameters						
VCC standby current	I_{VCCST}	IN1=IN2= IN3= IN4=L;VCC=7V;	--	0	10	uA
VM standby current	I_{VMST}	VM=10V;output floating	--	0	10	
VCC DC Current	I_{VCC}	INx=H; output floating	--	182	--	uA
VM DC Current	I_{VM}	INx=H; output floating	--	83	--	
Logic Input Voltage						
Input High Voltage	V_{INH}		2	--	--	V
Input Low Voltage	V_{INL}		--	--	0.8	
Input Voltage Delay	V_{HYS}			0.6		
Input High Voltage Current	I_{INH}	V_{INH}=2.5V;VCC=3V		191		uA
Input On Resistance	R_{IN}	V_{INH}=3V;VCC=3V		12		KΩ
Power Transistor On Resisitance						
Line1 On Resistance	R_{ON1}	IO=±200mA VM=6V TA=25℃		0.49		Ω
		IO=±800mA VM=6V TA=25℃		0.53		
Line2 On Resistance	R_{ON2}	IO=±200mA VM=6V TA=25℃		0.49		
		IO=±800mA VM=6V TA=25℃		0.53		
Protect function						
Thermal Shut Down Temperature	TSD		--	150	--	℃
Thermal Shut Down Hysteresis	TSDH		--	20	--	
Power MOSFET Body Diode Characteritics-1 line						
PMOS Body Diode	V_{PD}	I=400mA,VCC=3V, VM=IN1=IN2=0V		0.76		V
NMOS Body Diode	V_{ND}	I=-400mA, VCC=VM=3V, IN1=IN2=0V		0.75		
Power MOSFET Body Diode Characteritics-2 line						
PMOS Body Diode	V_{PD}	I=400mA,VCC=3V, VM=IN3=IN4=0V		0.76		V
NMOS Body Diode	V_{ND}	I=-400mA, VCC=VM=3V, IN3=IN4=0V		0.75		
Motor Drive time parameters-1 Line						
Output Rise Time	t_r	IN2=H,IN1 plus input 50%		300		ns
Output Fall Time	t_f			10		
Output delay (r-f)	t_{rf}	f=20KHz		40		
Output delay (f-r)	t_{fr}	load driver R=1.3Ω,		240		
Motor Drive time parameters-2 Line						
Output Rise Time	t_r	IN4=H,IN3 plus input50%		300		ns
Output Fall Time	t_f			10		
Output delay (r-f)	t_{rf}	f=20KHz		40		
Output delay (f-r)	t_{fr}	load driver R=1.3Ω,		240		

Remark：x respond 1、2、3 or 4.

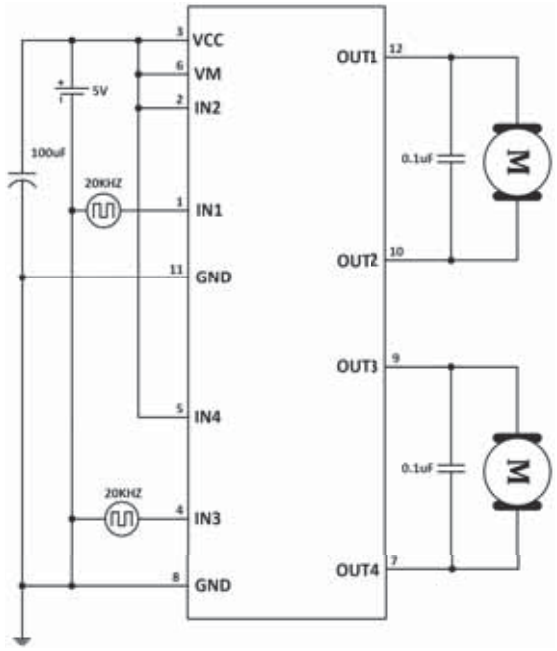
Test Schematic Program



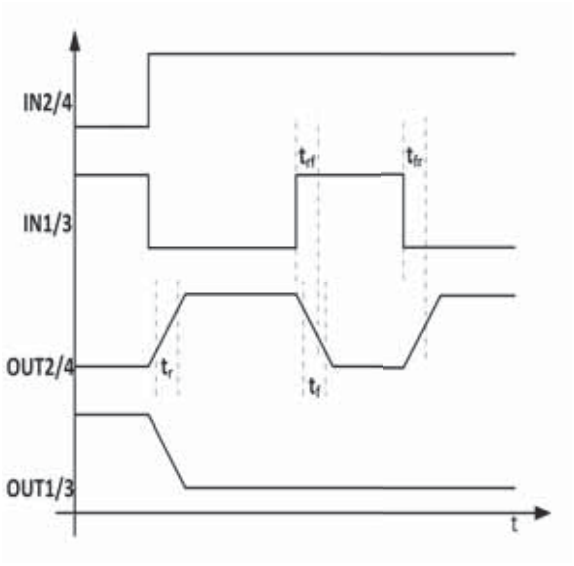
PMOS body diode On Voltage test schematic



NMOS body diode On Voltage test schematic

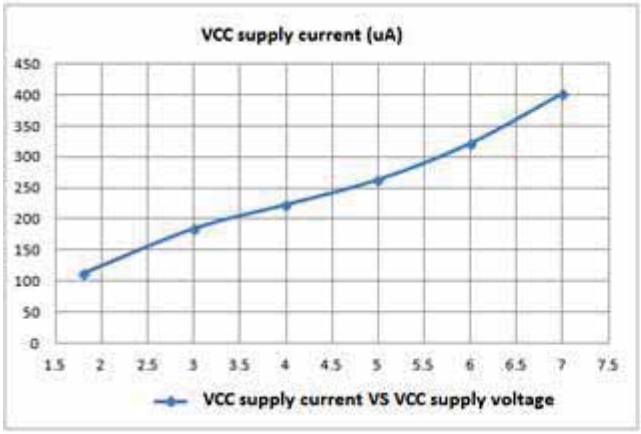


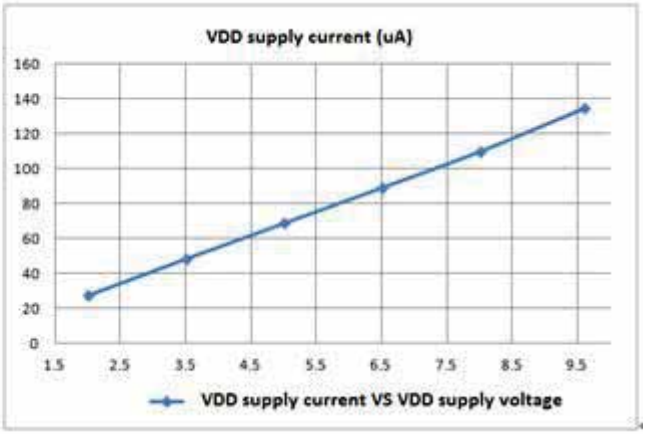
Time parameters test schematic

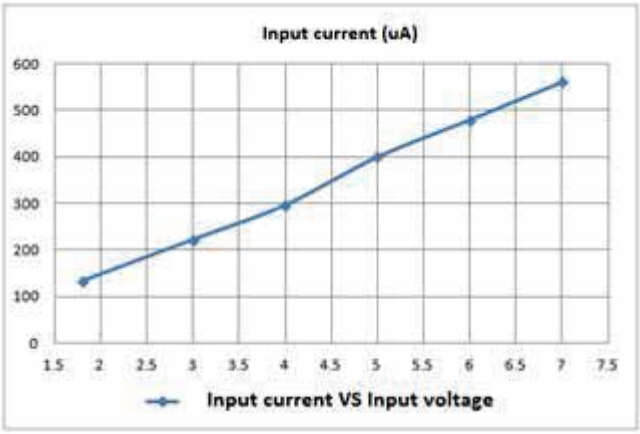


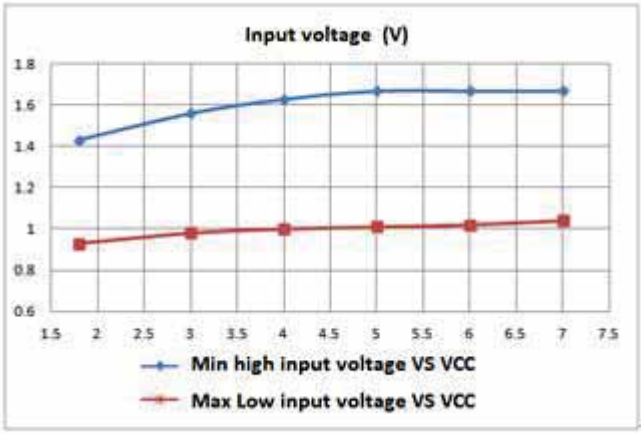
Time parameters definition

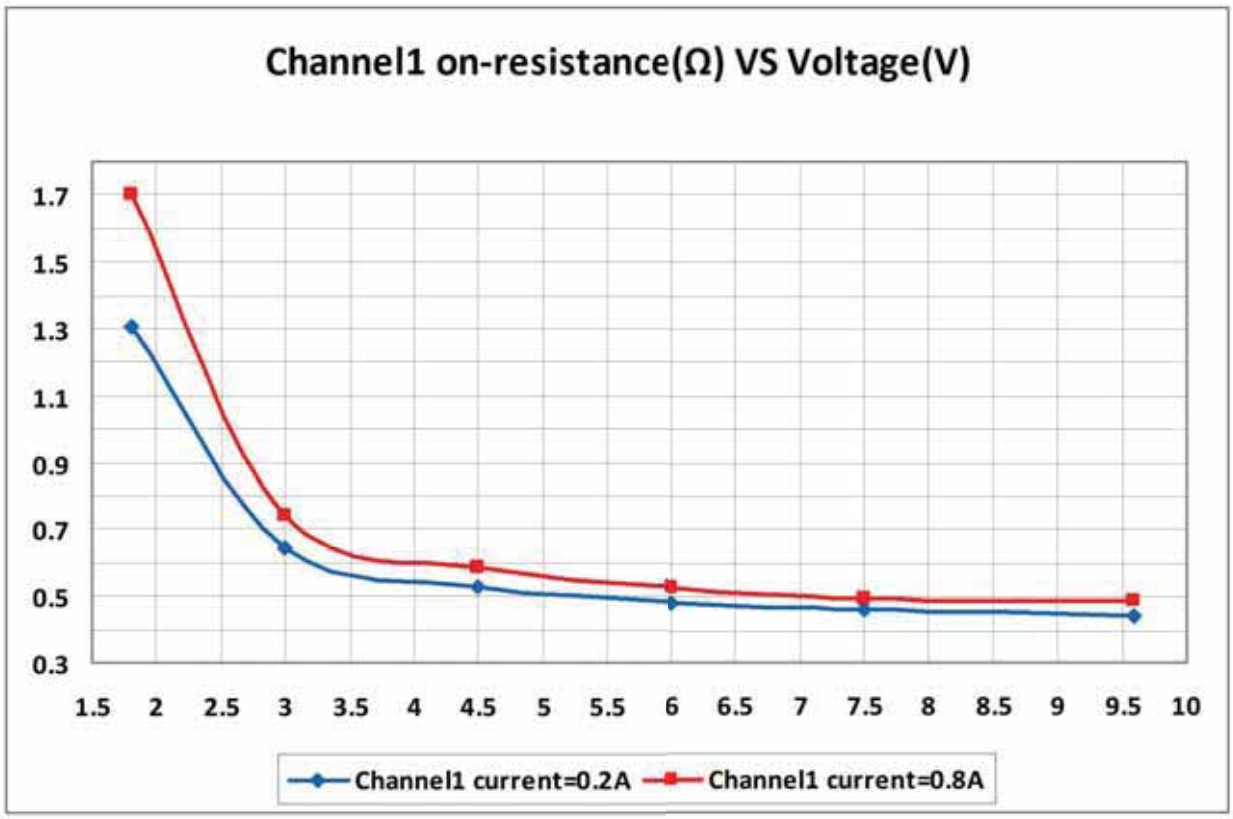
Characteristic Performance





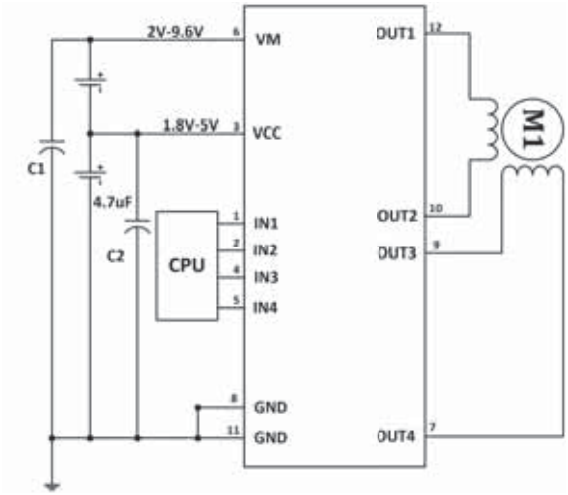




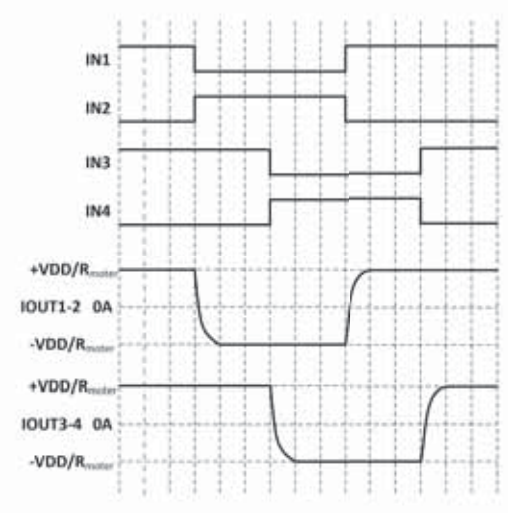


Application Information

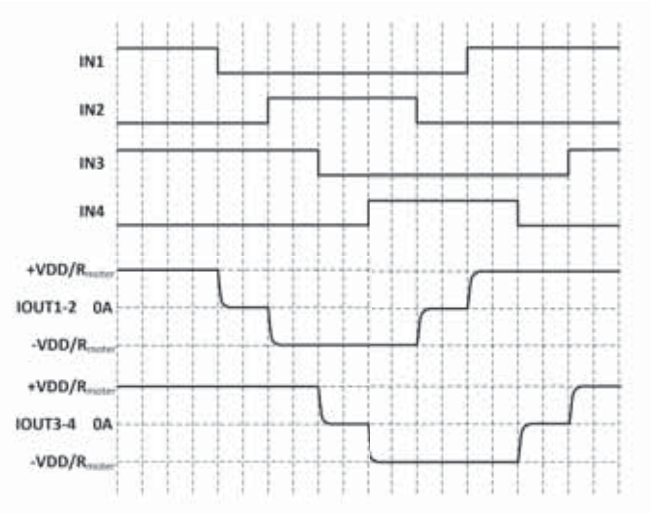
1、 Typical stepper motor control application



Typical stepper motor control application

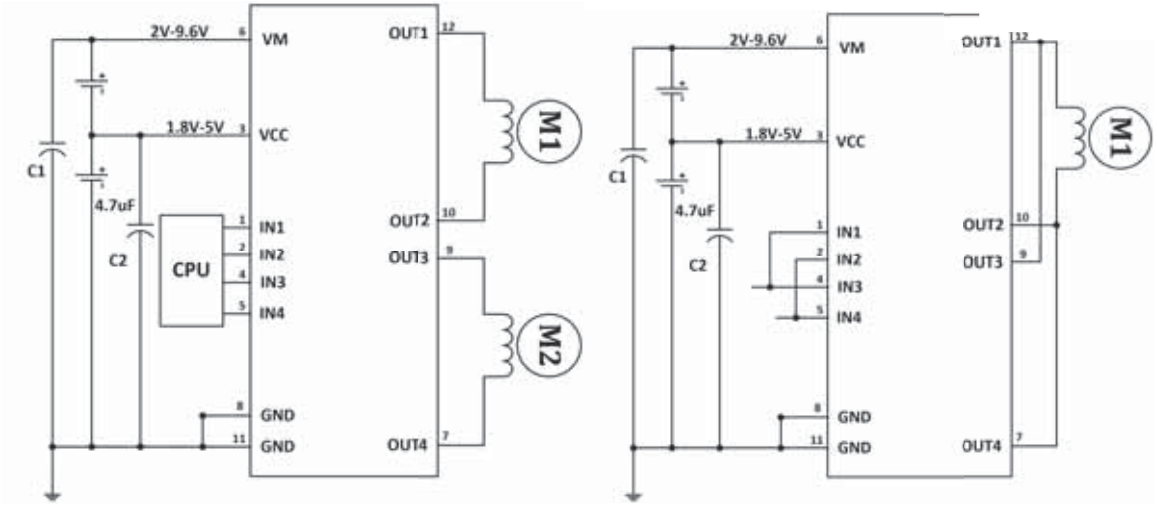


Full step mode timing chart



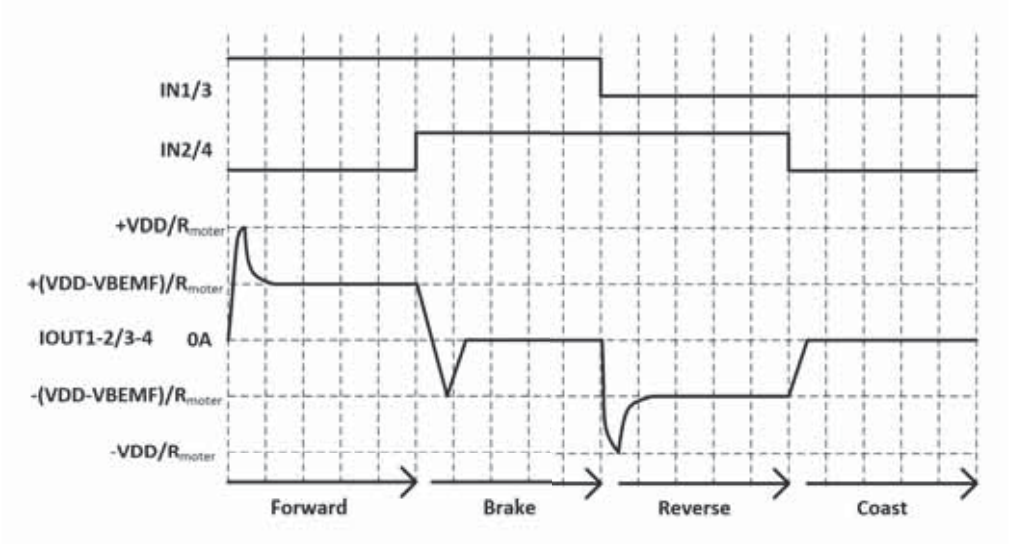
Half step mode timing chart

2、 dc motor control application

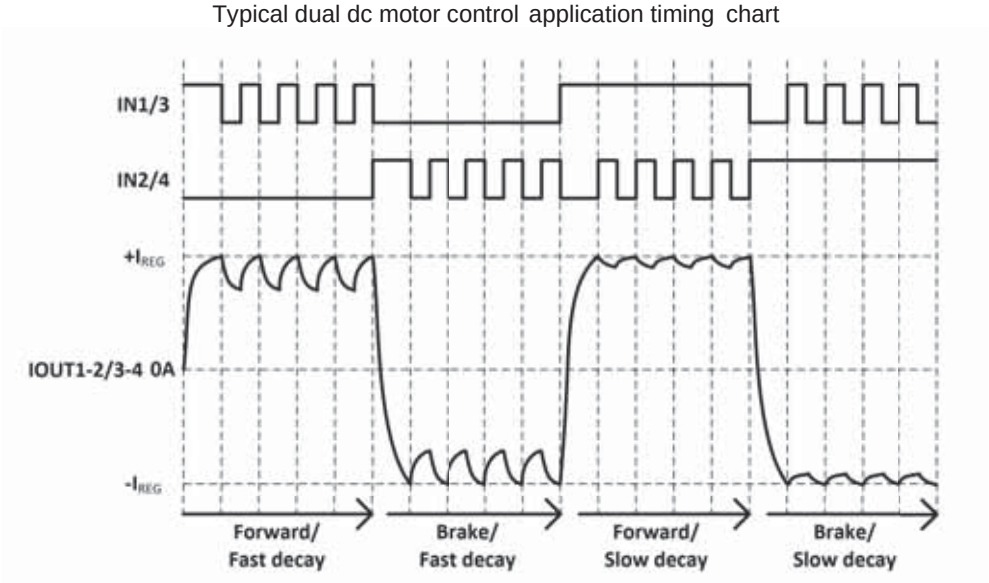


Typical dual dc motor control application

Typical single dc motor control (paralleled outputs)



Typical dual dc motor control application timing chart



External PWM current control in fast and slow delay modes

Notice：

the decoupling C1 funtion is connected between power and ground,the C1 value is as various as actual application,details as below:

A, the C1 can be removed if the VM voltage is less than 7.2V and the peak current is less than 2A

B, if the VM votage is between 7.2 and 9.6V,peak current over 2A,the C1 must added and the

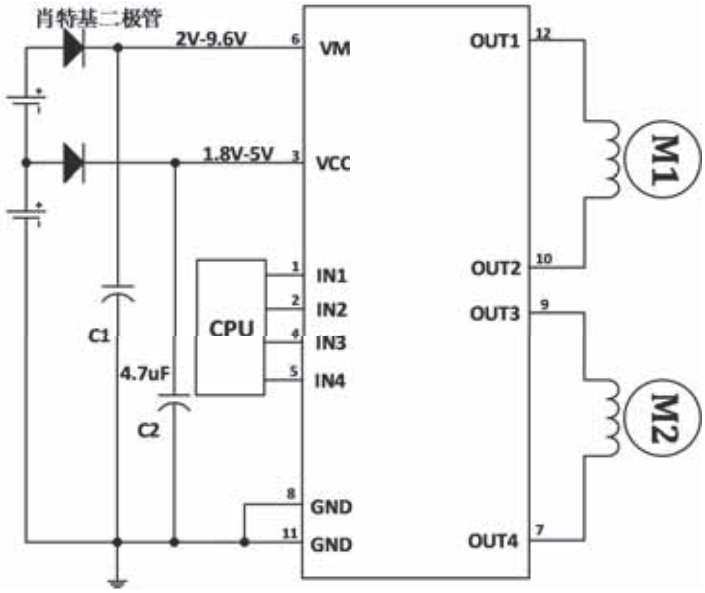
value should be from 47uF to 100uF.

C, ceramic or electrolytic capacitor are fit for C1.

the C2 that connect the logic suplly to ground is 4.7uF at least,it is not necessary to add one more capacitor that close the IC,C2 can share the capacitor with RX2,MCU. if there are not capacitor between VCC and ground,if occur OTP,will cut in lock function, changing the singal input to recover,.no lock stutas occur if the capacitor is over 4.7uF.

Pls mind:

1, the circuit can be damaged if reverse connection between supply and ground.adding 2 schottky diodes can prevent damage



2, decouple capacitor C1 has two function:1,absorb more motor energy to enable the voltage constant,avoid the over voltage damage.2,can spply high peak current for motor starting,the value of decople capacitor can be 4.7uF to 100Uf

3, ESD protection:PLS note the ESD protection at any status,specially in production line.

4, PLS make sure that do not short the output

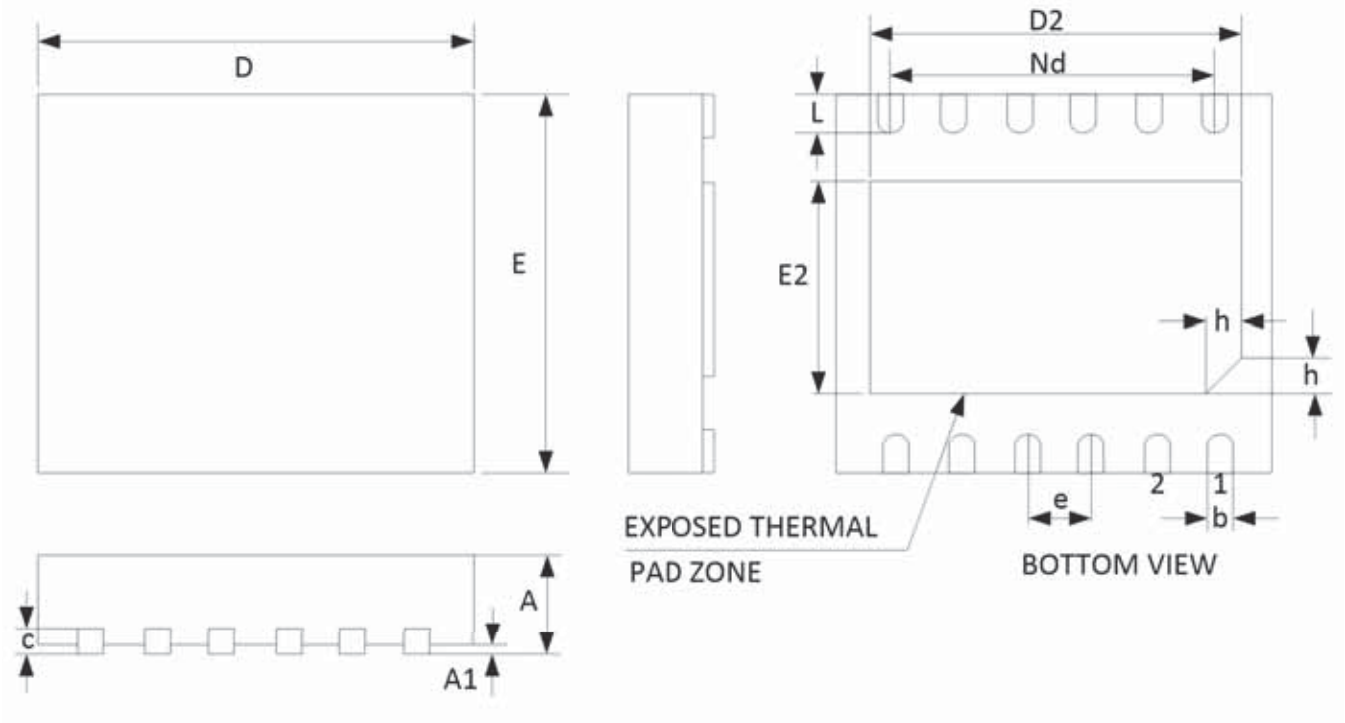
5, PLS make sure that do not short the Low output to the power supply

6, PLS prevent the motor working abnormally.

7, PLS make sure that the peak current do not over the rated current.

Package

DFN12：



SYMBOL	MILLMETER		
	MIN	NOM	MAX
A	0.70	0.75	0.80
A1	-	0.02	0.05
b	0.16	0.23	0.28
c	0.18	0.20	0.25
D	2.90	3.00	3.10
D2	2.40	2.50	2.60
e	0.45BSC		
Nd	2.25BSC		
E	2.90	3.00	3.10
E2	1.45	1.55	1.65
L	0.30	0.40	0.50
h	0.20	0.25	0.30
L/F Base（mil）	106*75		

Version Log

V1.0 The primary version;

V1.1 Revise some mistakes in the electric characteristic test condition.