# 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

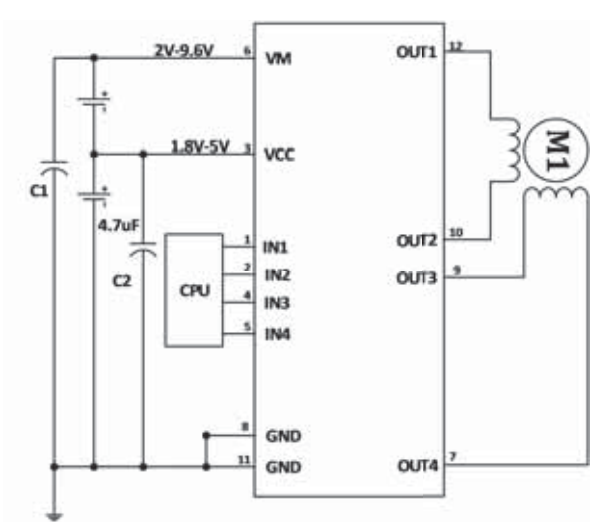



Figure 1. Typical stepper motor control

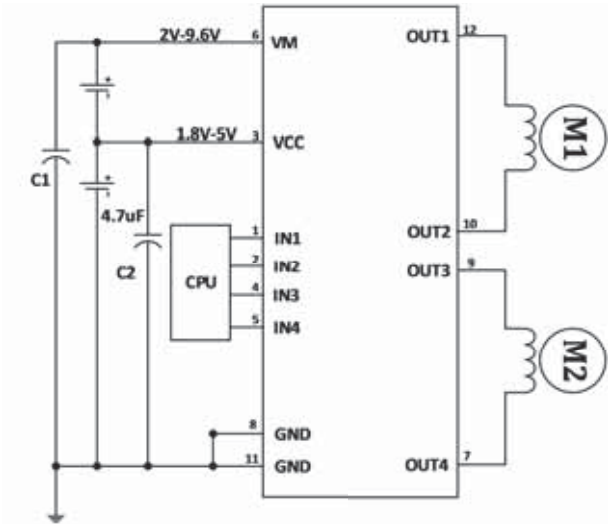



Figure 2. Typical dual dc motor control

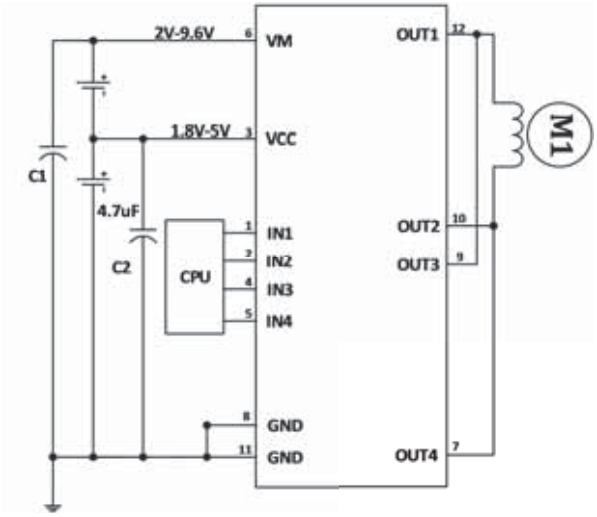
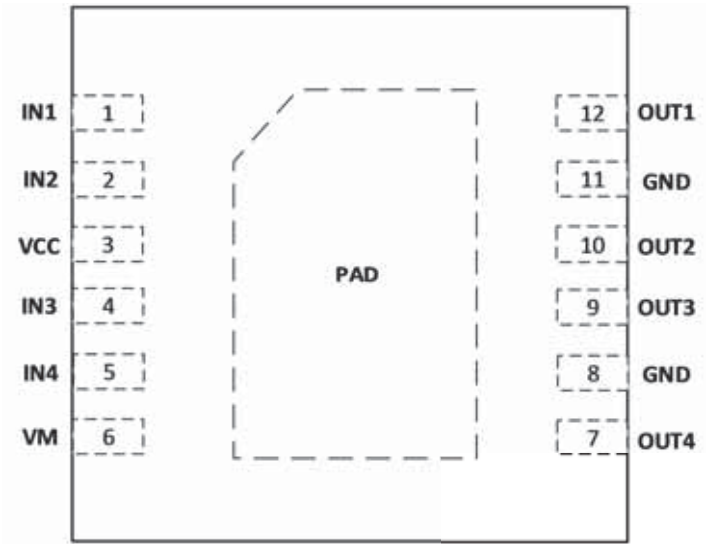



Figure 3. Typical single dc motor control (paralleled outputs)

## Selection Guide

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

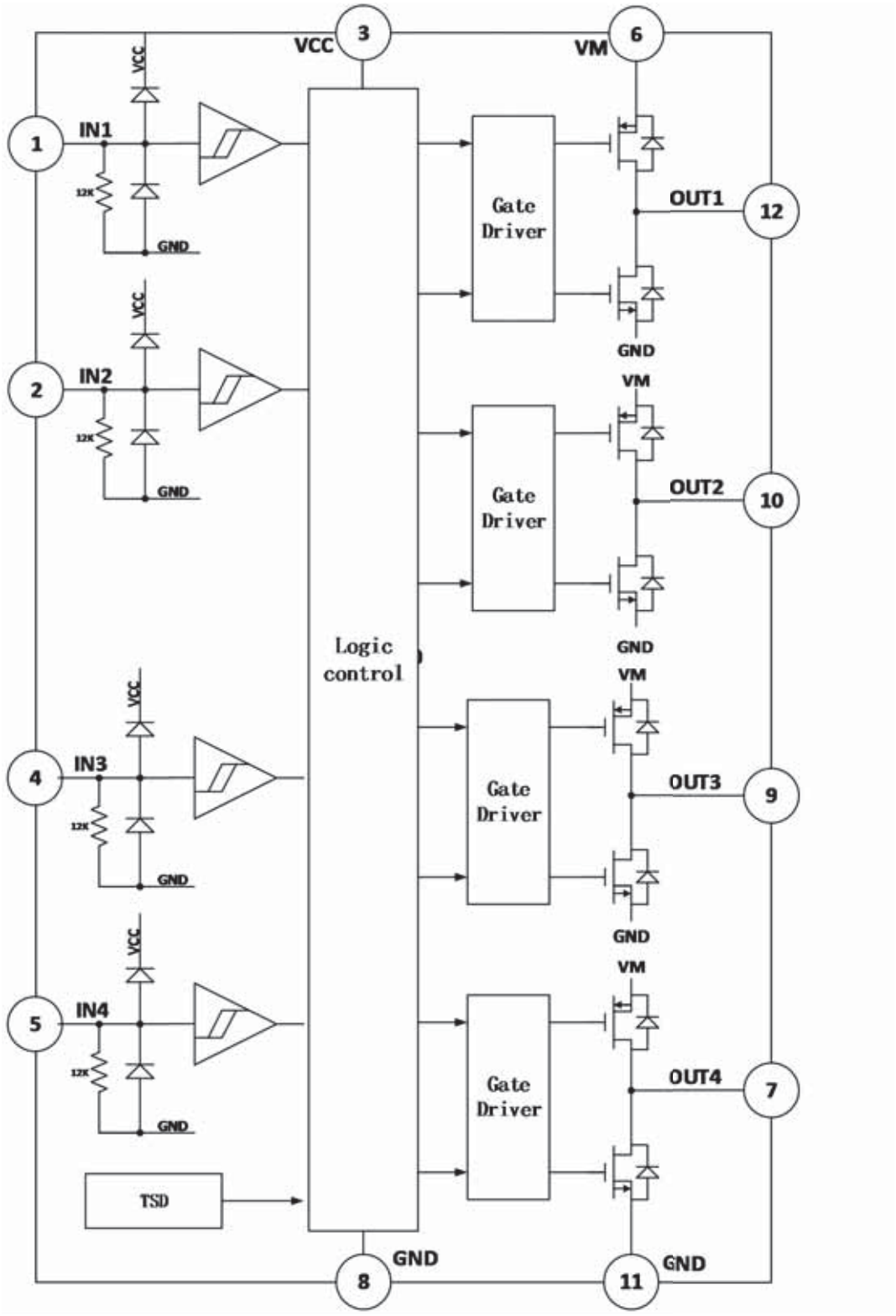
## Package Diagram



| 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<br>0 | | 0<br>0 | | H<br>OFF | L<br>OFF | H<br>OFF | L<br>OFF | Forward<br>Fast Decay | |
| 0<br>0 | | 1<br>0 | | L<br>OFF | H<br>OFF | L<br>OFF | H<br>OFF | Reverse<br>Fast Decay | |
| 1<br>1 | | 0<br>1 | | H<br>L | L<br>L | H<br>L | L<br>L | Forward<br>Slow Decay | |
| 0<br>1 | | 1<br>1 | | L<br>L | H<br>L | L<br>L | H<br>L | Reverse<br>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 | $\theta_{JAD}$ | -- | ℃/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, $\theta_{JA}$ 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.

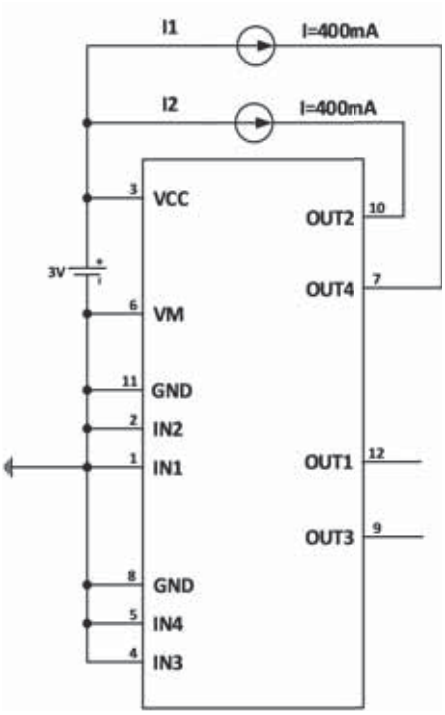
(3)、continuous output current test condition: Mount and PCB test .

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

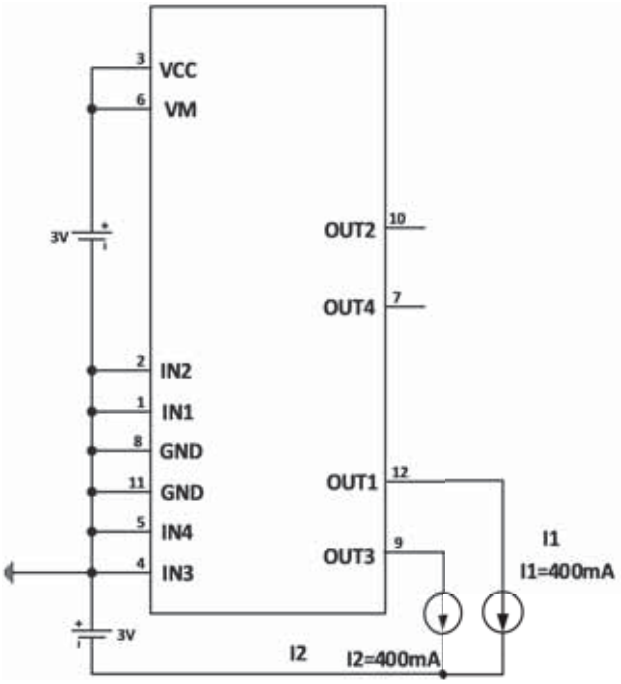
| Characteristics | Symbol | Test Conditions | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|
| **Motor Supply Parameters** | | | | | | |
| VCC standby current | $I_{VCCST}$ | IN1=IN2= IN3= IN4=L;VCC=7V; | -- | 0 | 10 | uA |
| VM standby current | $I_{VMST}$ | VM=10V;output floating | -- | 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.

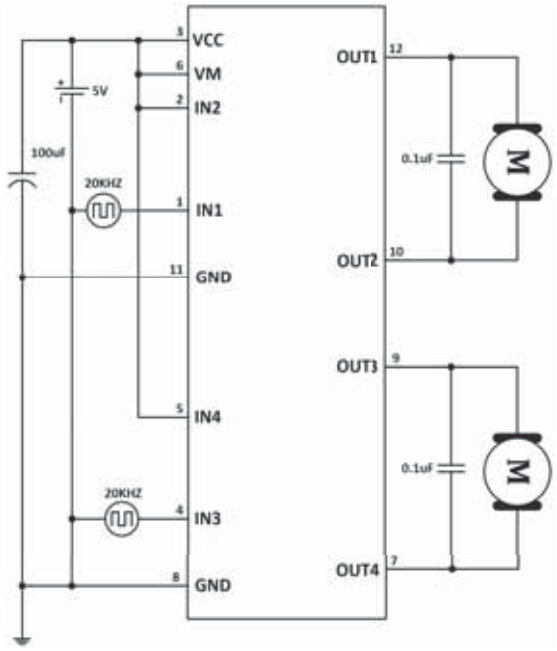
## Test Schematic Program



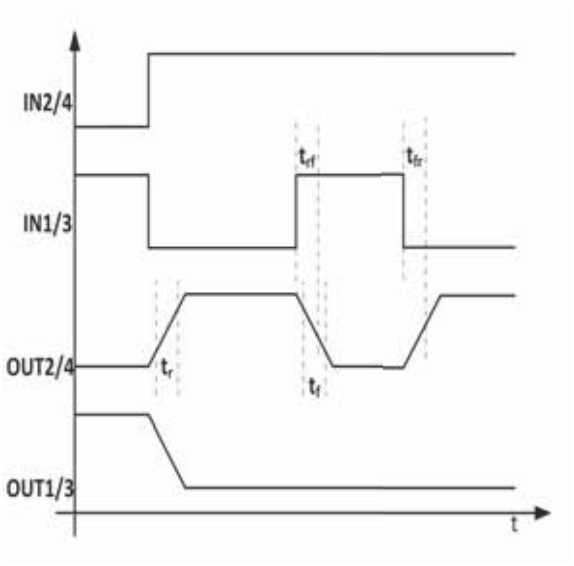

PMOS body diode On Voltage test schematic




NMOS body diode On Voltage test schematic

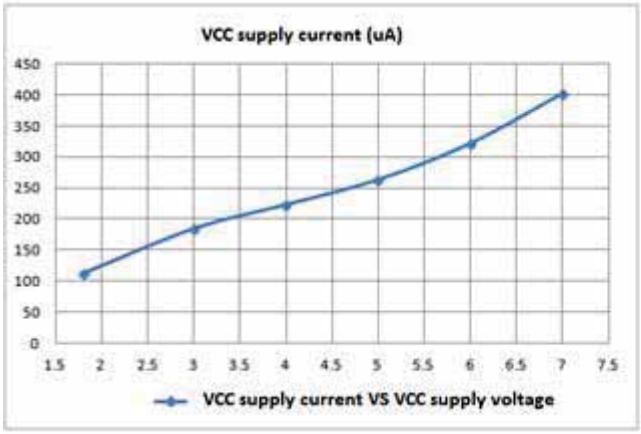


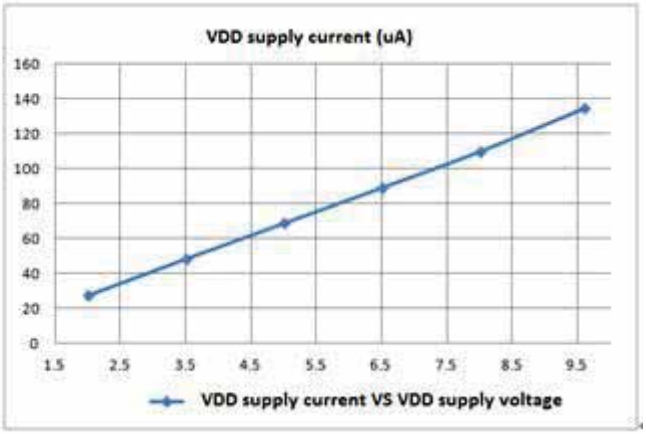

Time parameters test schematic

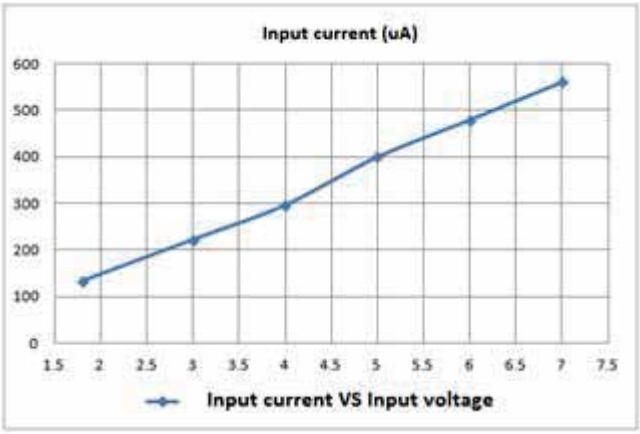


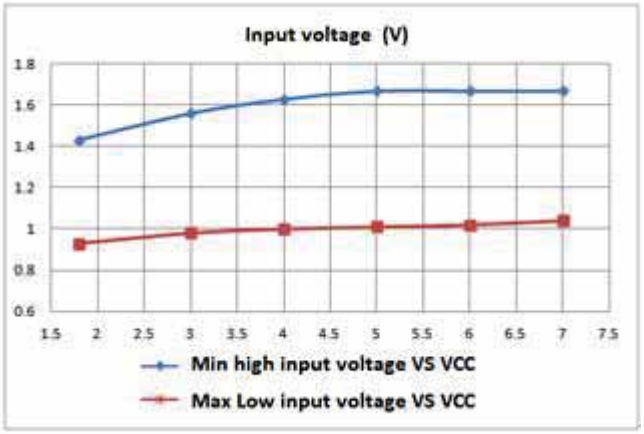

Time parameters definition

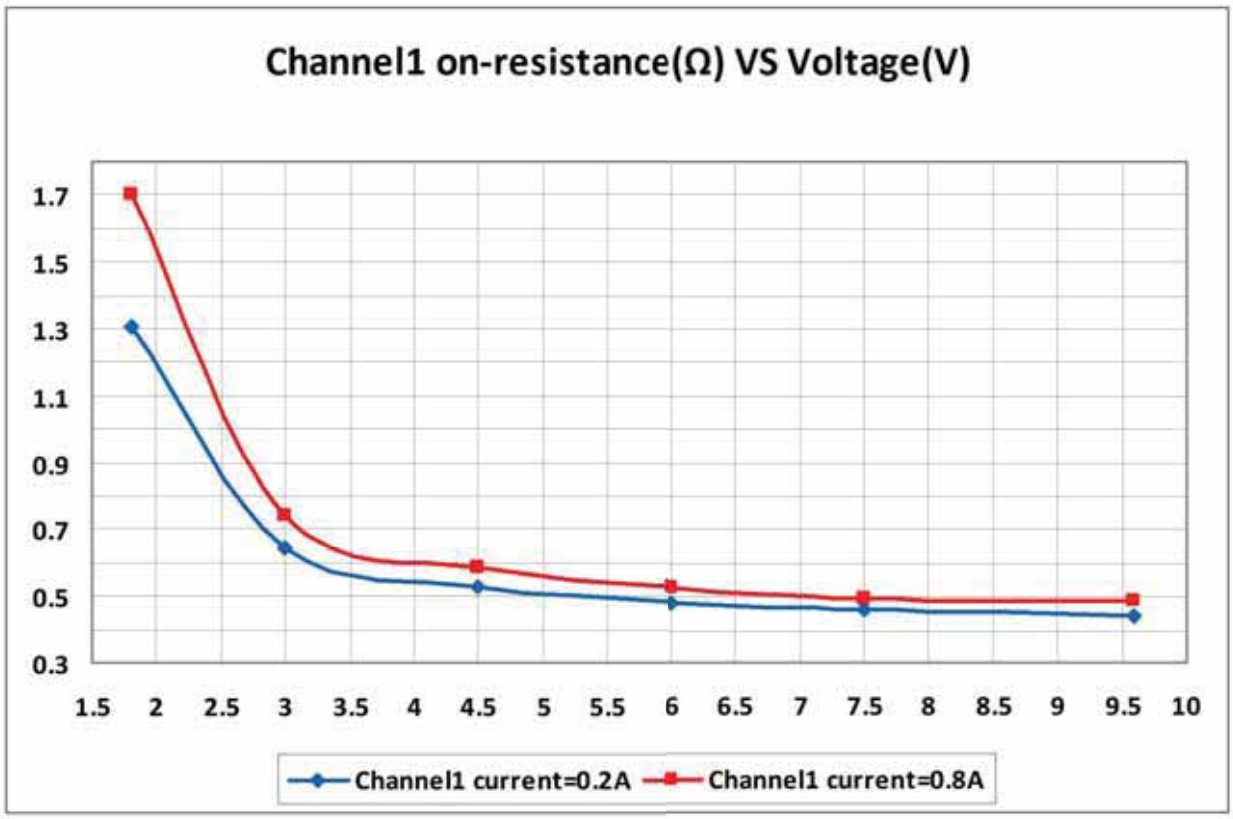
## Characteristic Performance



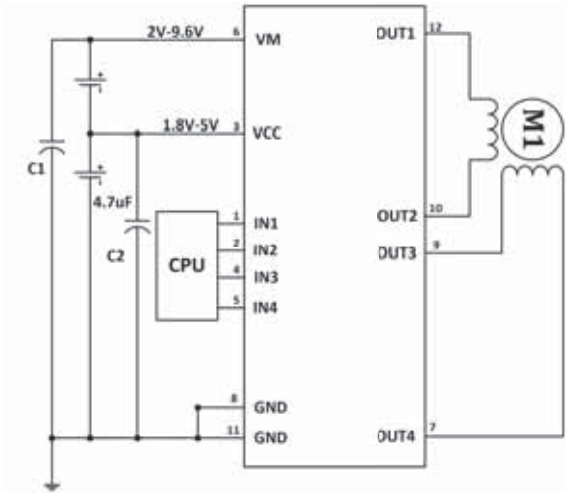



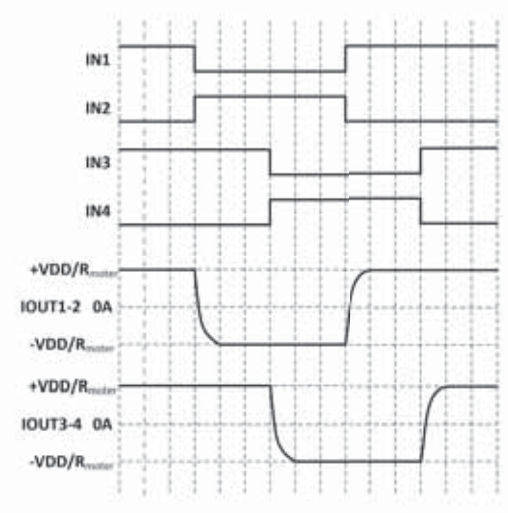



## Application Information

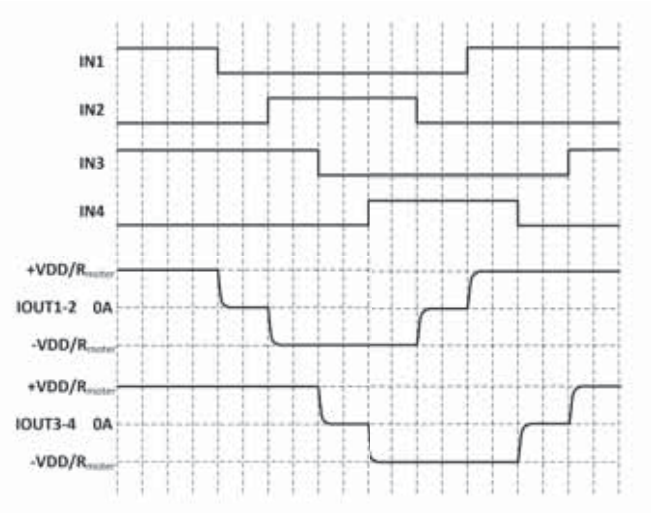
### 1、 Typical stepper motor control application




Typical stepper motor control application

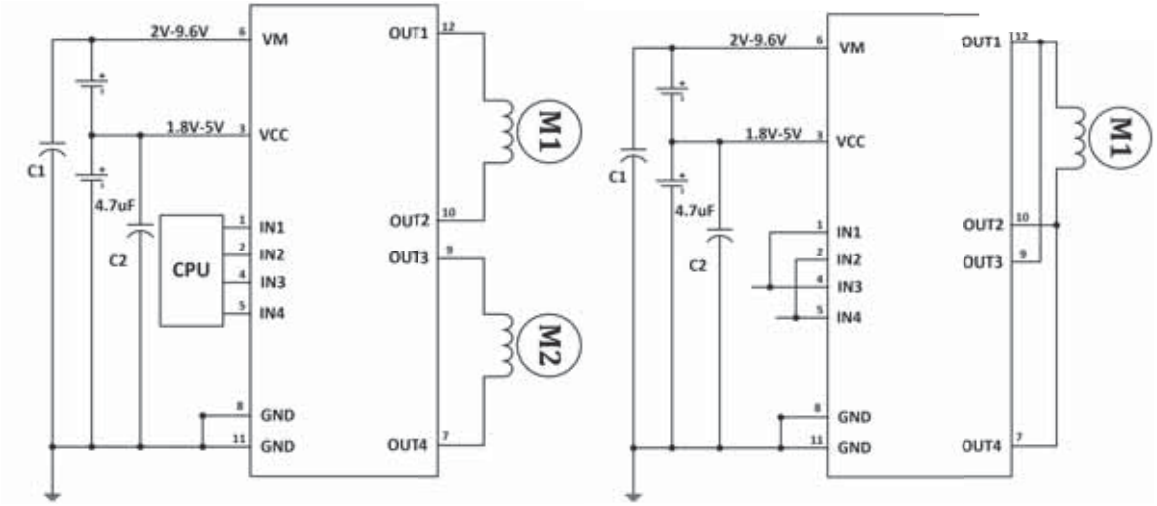



Full step mode timing chart



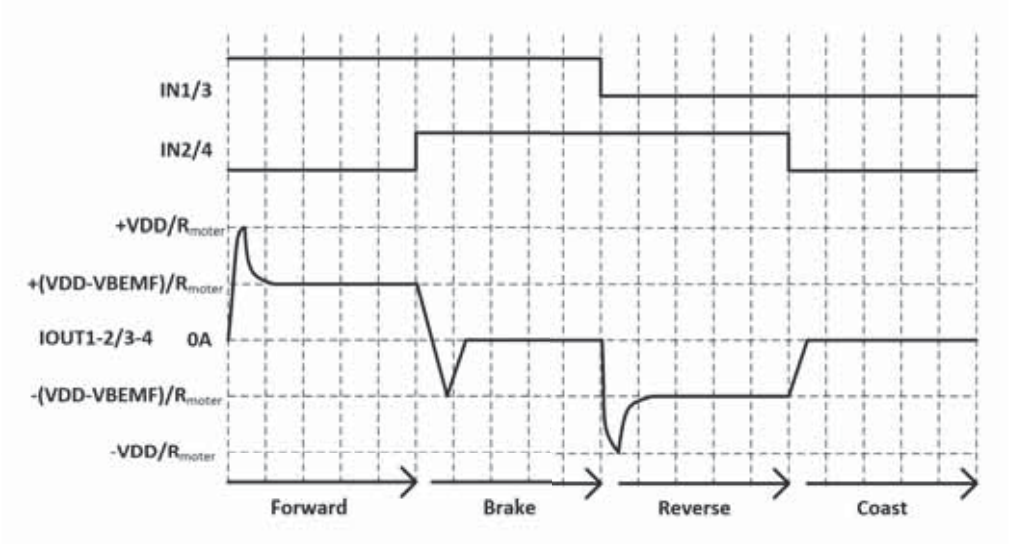

Half step mode timing chart

### 2、 dc motor control application

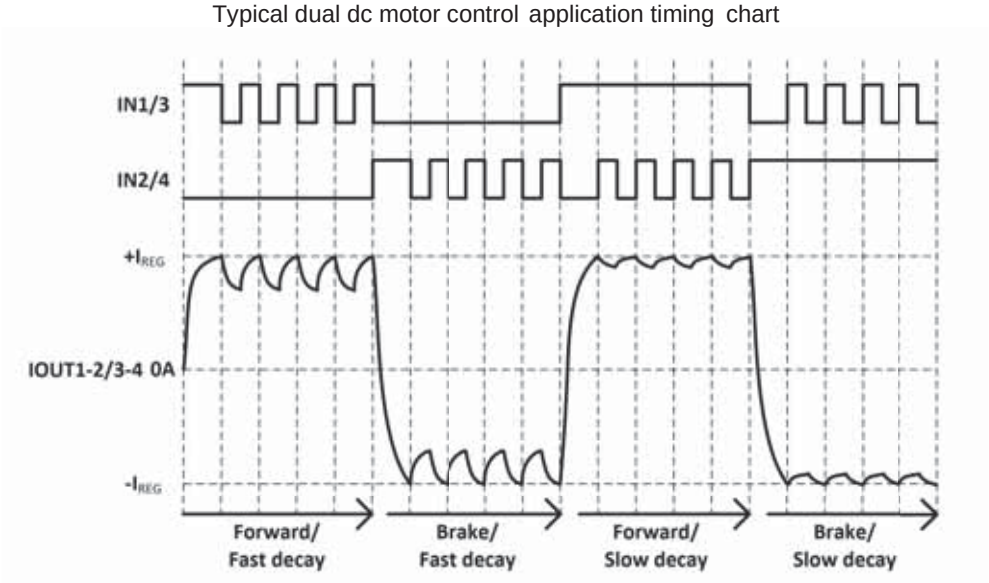



Typical dual dc motor control application

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**

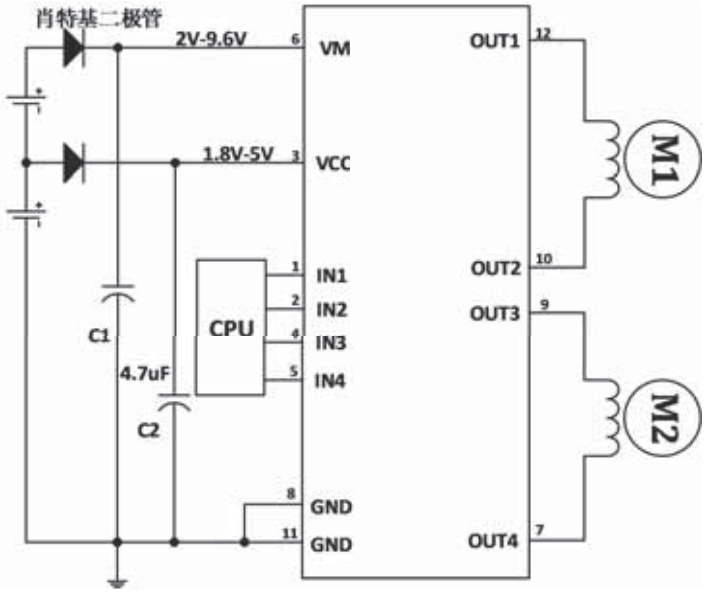
**value should be from 47uF to 100uF.**

**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**

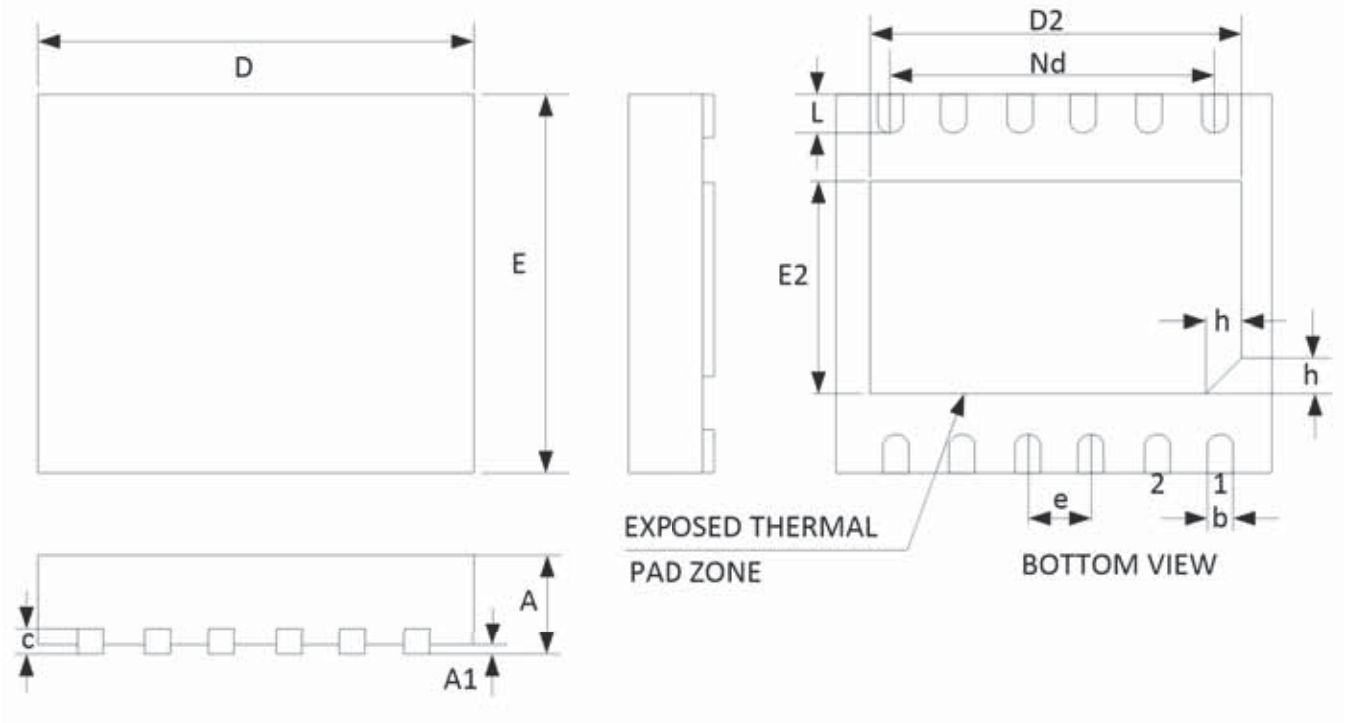
**5, PLS make sure that do not short the Low output to the power supply**

**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.

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