



## 智能功率模块：600V /10A 三相全桥驱动 NSMD10S60C1

### 1 特点

- 内置 6 个 600V/10A 的 MOS (Typ.  $R_{ds,on} = 0.417\Omega$  @25°C)
- 内置高压栅极驱动电路 (HVIC)
- 内置欠压保护
- 内置自举二极管
- 内置温度检测功能
- 内置栅驱动电路的电压范围从 12V 到 20V
- 3 个独立的负电流端用于需要电流检测的应用
- 兼容 3.3V 和 5V 的 MCU 接口，高电平有效
- 优化并采用了低电磁干扰设计
- 绝缘等级 1500Vrms/min

### 2 典型应用

- 室内/户外空调
- 冰箱压缩机
- 排风扇
- 风扇
- 空气净化器
- 洗碗机水泵

### 3 芯片概述

#### 3.1 特点

NSMD10S60C1 是高度集成、高可靠性的三相无刷直流电机驱动电路，主要应用于风扇类的小功率电机驱动。该模块内置了 6 个功率 MOS 管和 3 个半桥高压栅极驱动电路。

NSMD10S60C1 内部集成了欠压保护功能，提供了优异的保护和失效保护操作。由于每一相都有一个独立的负直流端，其电流可以分别单独检测。

NSMD10S60C1 采用了高绝缘、易导热和低电磁干扰的

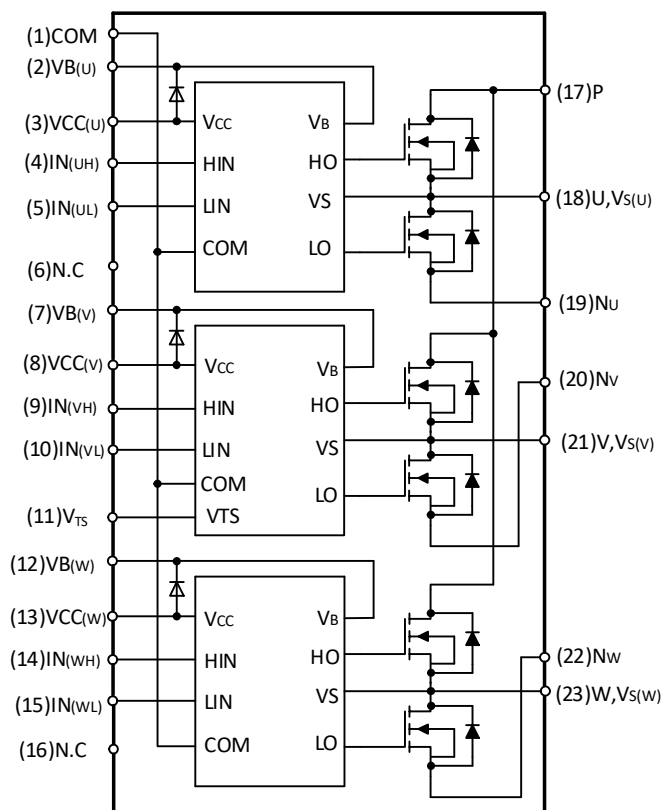
设计，提供了非常紧凑的封装体，使用非常方便，尤其适合内置于电机的应用和要求紧凑安装场合。

#### 3.2 芯片信息



| Part Number | Package | Body size   |
|-------------|---------|-------------|
| NSMD10S60C1 | SOP23   | 29mm x 12mm |

#### Functional Block Diagram



## 4 Ordering Guide

| Part Number | LOGO                                                                                                   | Package | Package     | SPQ |
|-------------|--------------------------------------------------------------------------------------------------------|---------|-------------|-----|
| NSMD10S60C1 |  NSMD10S60C1<br>XXXXX | SOP23   | Tape & Reel | 500 |

## 5 Revision history

| Version | Content | Time       |
|---------|---------|------------|
| V1.0    | Create  | 2022.10.10 |



# INDEX

|                                      |          |
|--------------------------------------|----------|
| <b>1 FEATURES AND BENEFITS</b>       | <b>1</b> |
| <b>2 TYPICAL APPLICATIONS</b>        | <b>1</b> |
| <b>3 DESCRIPTION</b>                 | <b>1</b> |
| 3.1 CHARACTERISTIC                   | 1        |
| 3.2 CHIP INFORMATION                 | 1        |
| <b>4 ORDERING GUIDE</b>              | <b>2</b> |
| <b>5 REVISION HISTORY</b>            | <b>2</b> |
| <b>6 FUNCTION PIN DESCRIPTION</b>    | <b>4</b> |
| <b>7 PRODUCT SPECIFICATIONS</b>      | <b>5</b> |
| 7.1 ABSOLUTE MAXIMUM RATINGS         | 5        |
| 7.2 RECOMMENDED OPERATING CONDITIONS | 5        |
| 7.3 ELECTRICAL CHARACTERISTICS       | 6        |
| <b>8 NSMD10S60C1 DESCRIPTION</b>     | <b>8</b> |
| <b>9 PACKAGE INFORMATION</b>         | <b>9</b> |

6 Function Pin Description

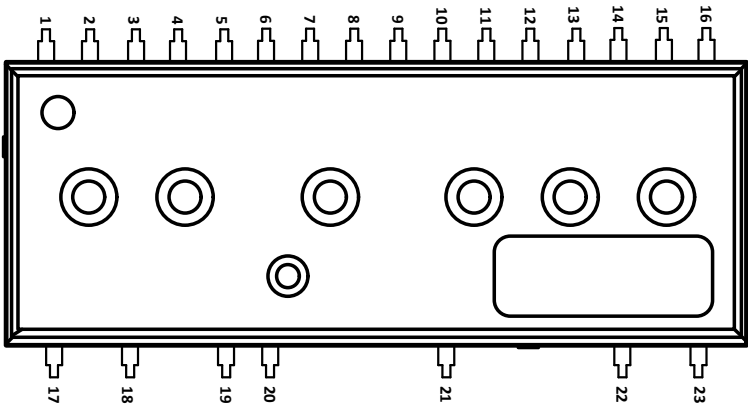


Figure6-1 23-Pin Top view

Table6-1 Lead Definitions

| Number | Symbol        | Description                                                           |
|--------|---------------|-----------------------------------------------------------------------|
| 1      | COM           | IC Common Supply Ground                                               |
| 2      | $V_{B(U)}$    | Bias Voltage for U-Phase High-Side MOSFET Driving                     |
| 3      | $V_{CC(U)}$   | Bias Voltage for U-Phase IC and Low-Side MOSFET Driving               |
| 4      | $IN_{(UH)}$   | Signal Input for U-Phase High-Side                                    |
| 5      | $IN_{(UL)}$   | Signal Input for U-Phase Low-Side                                     |
| 6      | N.C           | No Connection                                                         |
| 7      | $V_{B(V)}$    | Bias Voltage for V-Phase High Side MOSFET Driving                     |
| 8      | $V_{CC(V)}$   | Bias Voltage for V-Phase IC and Low Side MOSFET Driving               |
| 9      | $IN_{(VH)}$   | Signal Input for V-Phase High-Side                                    |
| 10     | $IN_{(VL)}$   | Signal Input for V-Phase Low-Side                                     |
| 11     | $V_{TS}$      | Output for HVIC Temperature Sensing                                   |
| 12     | $V_{B(W)}$    | Bias Voltage for W-Phase High-Side MOSFET Driving                     |
| 13     | $V_{CC(W)}$   | Bias Voltage for W-Phase IC and Low-Side MOSFET Driving               |
| 14     | $IN_{(WH)}$   | Signal Input for W-Phase High-Side                                    |
| 15     | $IN_{(WL)}$   | Signal Input for W-Phase Low-Side                                     |
| 16     | N.C           | No Connection                                                         |
| 17     | P             | Positive DC-Link Input                                                |
| 18     | $U, V_{S(U)}$ | Output for U-Phase & Bias Voltage Ground for High-Side MOSFET Driving |
| 19     | $N_U$         | Negative DC-Link Input for U-Phase                                    |
| 20     | $N_V$         | Negative DC-Link Input for V-Phase                                    |
| 21     | $V, V_{S(V)}$ | Output for V-Phase & Bias Voltage Ground for High-Side MOSFET Driving |
| 22     | $N_W$         | Negative DC-Link Input for W-Phase                                    |
| 23     | $W, V_{S(W)}$ | Output for W Phase & Bias Voltage Ground for High-Side MOSFET Driving |

## 7 Product specifications

### 7.1 Absolute Maximum Ratings

Exceeding the limit maximum rating may cause permanent damage to the device. All voltage parameters are rated with reference to COM and an ambient temperature of 25°C.

**Inverter Part** (each MOSFET unless otherwise specified)

| Symbol    | Definition                            | Conditions                                 | Rating   | Units            |
|-----------|---------------------------------------|--------------------------------------------|----------|------------------|
| $V_{DSS}$ | Drain-Source Voltage of Each MOSFET   |                                            | 600      | V                |
| $V_{GSS}$ | Gate-Source Voltage of Each MOSFET    | $T_C = 25^\circ\text{C}$                   | $\pm 30$ | V                |
| $I_D$     | Each MOSFET Drain Current, Continuous | $T_C = 25^\circ\text{C}$                   | TBD      | A                |
| $I_{DP}$  | Each MOSFET Pulse Current, Peak       | $T_C = 25^\circ\text{C}$ , Less than 100us | 10       | A                |
| $T_J$     | Maximum Junction Temperature          |                                            | 150      | $^\circ\text{C}$ |

**Control Part** (each HVIC unless otherwise specified)

| Symbol   | Definition             | Conditions                       | Rating                   | Units |
|----------|------------------------|----------------------------------|--------------------------|-------|
| $V_{CC}$ | Control Supply Voltage | Applied between $V_{CC}$ and COM | 20                       | V     |
| $V_{BS}$ | High-side Bias Voltage | Applied between $V_B$ and $V_S$  | 20                       | V     |
| $V_{IN}$ | Input Signal Voltage   | Applied between $V_{IN}$ and COM | $-0.3 \sim V_{CC} + 0.3$ | V     |

**Bootstrap Diode Part** (each bootstrap diode unless otherwise specified)

| Symbol     | Definition                         | Conditions                                       | Rating | Units |
|------------|------------------------------------|--------------------------------------------------|--------|-------|
| $V_{RRMB}$ | Maximum Repetitive Reverse Voltage |                                                  | 600    | V     |
| $I_{FB}$   | Forward Current                    | $T_C = 25^\circ\text{C}$                         | 0.25   | A     |
| $I_{FPB}$  | Forward Peak Current, Peak         | $T_C = 25^\circ\text{C}$ , Under 1ms Pulse Width | 0.5    | A     |

**Total System**

| Symbol    | Definition                     | Conditions                                                  | Rating         | Units            |
|-----------|--------------------------------|-------------------------------------------------------------|----------------|------------------|
| $T_J$     | Operating Junction Temperature |                                                             | $-40 \sim 150$ | $^\circ\text{C}$ |
| $T_{STG}$ | Storage Temperature            |                                                             | $-40 \sim 150$ | $^\circ\text{C}$ |
| $V_{ISO}$ | Isolation Voltage              | 60Hz, Sinusoidal, 1 minute, Connect Pins to Heat-Sink Plate | 1500           | Vrms             |

**Thermal Resistance**

| Symbol          | Definition                          | Conditions                                     | Rating | Units                     |
|-----------------|-------------------------------------|------------------------------------------------|--------|---------------------------|
| $R_{\theta JC}$ | Junction to Case Thermal resistance | Each MOSFET under Inverter Operating Condition | 7.1    | $^\circ\text{C}/\text{W}$ |

Note1: To insure safe operation of the IPM, the average junction temperature should be limited to  $T_J \leq 150^\circ\text{C}$  ( $@T_C \leq 100^\circ\text{C}$ ).

### 7.2 Recommended Operating Conditions

| Symbol        | Parameter                              | Condition                                                                | MIN. | TYP. | MAX. | Units |
|---------------|----------------------------------------|--------------------------------------------------------------------------|------|------|------|-------|
| $V_{PN}$      | Supply Voltage                         | Applied between P and N                                                  | -    | 300  | 400  | V     |
| $V_{CC}$      | Control Supply Voltage                 | Applied between $V_{CC}$ and COM                                         | 12   |      | 18.5 | V     |
| $V_{BS}$      | High-Side Bias Voltage                 | Applied between $V_B$ and $V_S$                                          | 12   |      | 18.5 | V     |
| $V_{IN(ON)}$  | Input ON Threshold Voltage             | Applied between $V_{IN}$ and COM                                         | 3.0  | -    | VCC  | V     |
| $V_{IN(OFF)}$ | Input OFF Threshold Voltage            |                                                                          | 0    | -    | 0.6  | V     |
| $t_{dead}$    | Blanking Time for Preventing Arm-Short | $V_{CC} = V_{BS} = 13.5 \sim 16.5 \text{ V}$ , $T_J < 150^\circ\text{C}$ | 1.0  | -    | -    | us    |
| $f_{PWM}$     | PWM Switching Frequency                | $T_J < 150^\circ\text{C}$                                                | -    | 15   | -    | KHz   |

### 7.3 Electrical Characteristics

Valid for temperature range at  $T_A = 25^\circ\text{C}$ , unless otherwise specified

**Inverter Part**(each MOSFET unless otherwise specified)

| Symbol       | Parameter                              | Condition                                                                                                                                                                                             | MIN.        | TYP. | MAX. | Units            |
|--------------|----------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|------|------|------------------|
| $BV_{DSS}$   | Drain - Source Breakdown Voltage       | $V_{GS} = 0\text{ V}, I_D = 100\text{ }\mu\text{A}$                                                                                                                                                   | 650         | -    | -    | V                |
| $I_{DSS}$    | Zero Gate Voltage Drain Current        | $V_{GS} = 0\text{ V}, V_{DS} = 650\text{ V}$                                                                                                                                                          | -           | 0.1  | 20   | $\mu\text{A}$    |
| $R_{DS(on)}$ | Static Drain-Source Turn-On Resistance | $V_{DS} = 10\text{ V}, I_D = 4.5\text{ A}$                                                                                                                                                            | -           | 480  | -    | $\text{m}\Omega$ |
| $V_{FSD}$    | Drain - Source Diode Forward Voltage   | $V_{GS} = 0\text{ V}, I_S = 2.5\text{ A}$                                                                                                                                                             | -           | 3.9  | -    | V                |
| $t_{ON}$     | Switching Times                        | $V_{PN} = 300\text{ V}, V_{CC} = V_{BS} = 15\text{ V}, I_D = 0.5\text{ A}$<br>$I_N = 0\text{ V} \leftrightarrow 5\text{ V}$ , Inductive Load $L = 3\text{ mH}$<br>High- and Low-Side MOSFET Switching | -           | 870  | -    | ns               |
| $t_{OFF}$    |                                        |                                                                                                                                                                                                       | -           | 480  | -    | ns               |
| $t_{rr}$     |                                        |                                                                                                                                                                                                       | -           | 78   | -    | ns               |
| $E_{ON}$     |                                        |                                                                                                                                                                                                       | -           | 46   | -    | $\mu\text{J}$    |
| $E_{OFF}$    |                                        |                                                                                                                                                                                                       | -           | 15   | -    | $\mu\text{J}$    |
| RBSOA        | Reverse Bias Safe Operating Area       | $V_{PN} = 400\text{ V}, V_{CC} = V_{BS} = 15\text{ V}, I_D = I_{DP}$ ,<br>$V_{DS} = B_{VDS}, T_J = 150^\circ\text{C}$ High- and Low-Side MOSFET Switching                                             | Full Square |      |      |                  |

**Control Part**(each HVIC unless otherwise specified)

| Symbol    | Parameter                               | Condition                                           |                                                                     | MIN. | TYP. | MAX. | Units         |
|-----------|-----------------------------------------|-----------------------------------------------------|---------------------------------------------------------------------|------|------|------|---------------|
| $I_{QCC}$ | Quiescent VCC Supply Current            | $V_{CC} = 15\text{ V}$<br>$V_{IN} = 0\text{ V}$     | Applied between VCC and COM                                         | -    | 80   | 180  | $\mu\text{A}$ |
| $I_{QBS}$ | Quiescent VB Supply Current             | $V_{BS} = 15\text{ V}$<br>$V_{IN} = 0\text{ V}$     | Applied between $V_{B(U)} - U$ ,<br>$V_{B(V)} - V$ , $V_{B(W)} - W$ | -    | 30   | 60   | $\mu\text{A}$ |
| $V_{CCD}$ | Low-side UVLO threshold                 | VCC Under-Voltage Protection Detection Level        |                                                                     | -    | 11.5 | -    | V             |
| $V_{CCR}$ |                                         | VCC Under-Voltage Protection Reset Level            |                                                                     | -    | 10.5 | -    | V             |
| $V_{BSD}$ | High-side UVLO threshold                | VBS Under-Voltage Protection Detection Level        |                                                                     | -    | 11.5 | -    | V             |
| $V_{BSR}$ |                                         | VBS Under-Voltage Protection Reset Level            |                                                                     | -    | 10.5 | -    | V             |
| $V_{TS}$  | HVIC Temperature Sensing Voltage Output | $V_{CC} = 15\text{ V}, T_{HVIC} = 25^\circ\text{C}$ |                                                                     | 320  | 650  | 900  | mV            |
| $V_{IH}$  | ON Threshold Voltage                    | Logic HIGH Level                                    | Applied between $V_{IN}$ and COM                                    | -    | -    | 2.6  | V             |
| $V_{IL}$  | OFF Threshold Voltage                   | Logic LOW Level                                     |                                                                     | 0.8  | -    | -    | V             |

**Control Part**(each bootstrap diode unless otherwise specified)

| Symbol    | Parameter                     | Condition                                    | MIN. | TYP. | MAX. | Units |
|-----------|-------------------------------|----------------------------------------------|------|------|------|-------|
| VF        | BSD Forward voltage           | $I_F = 0.1\text{ A}, T_C = 25^\circ\text{C}$ | -    | 2.8  | -    | V     |
| $t_{rrB}$ | Reverse Recovery Time         | $I_F = 0.1\text{ A}, T_C = 25^\circ\text{C}$ | -    | 80   | -    | ns    |
| R         | BSD Current Limiting Resistor |                                              | -    | 100  | -    | ohm   |

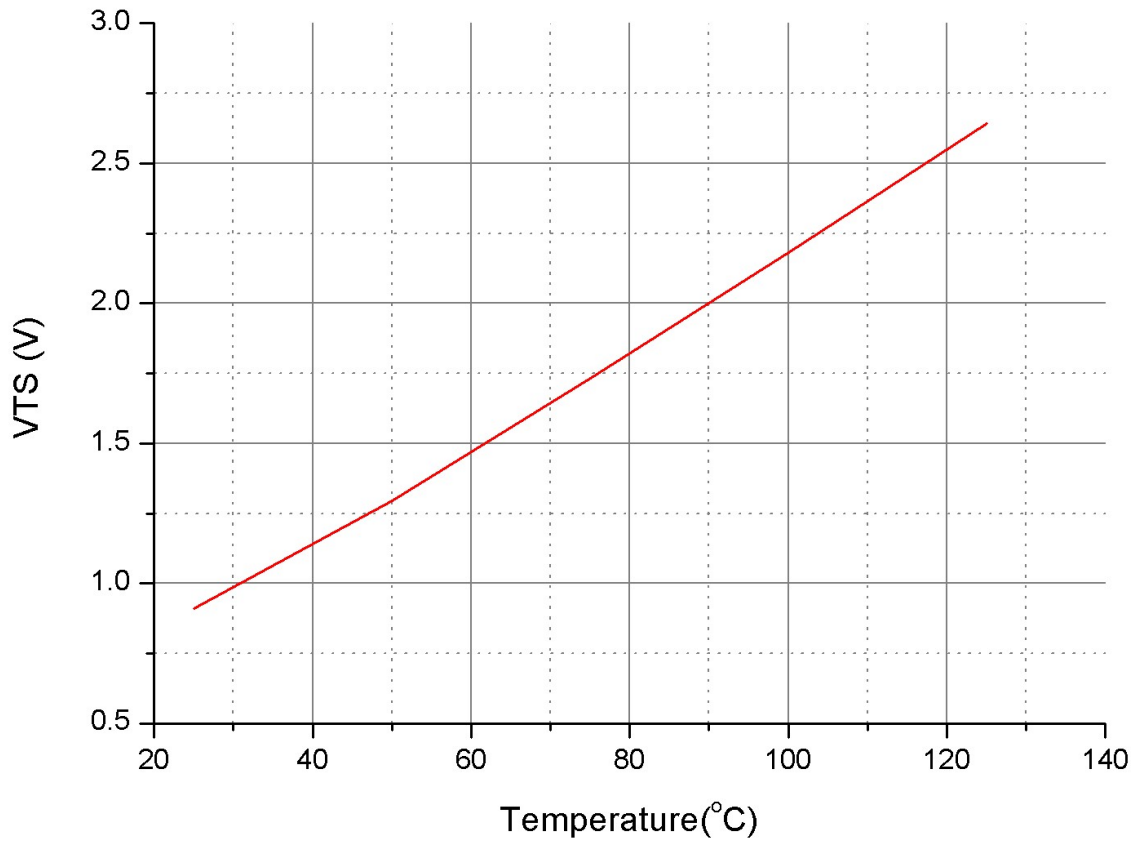


Figure7-1 Temperature Profile of  $V_{TS}$ (Typical)

## 8 NSMD10S60C1 Description

### Typical application circuit

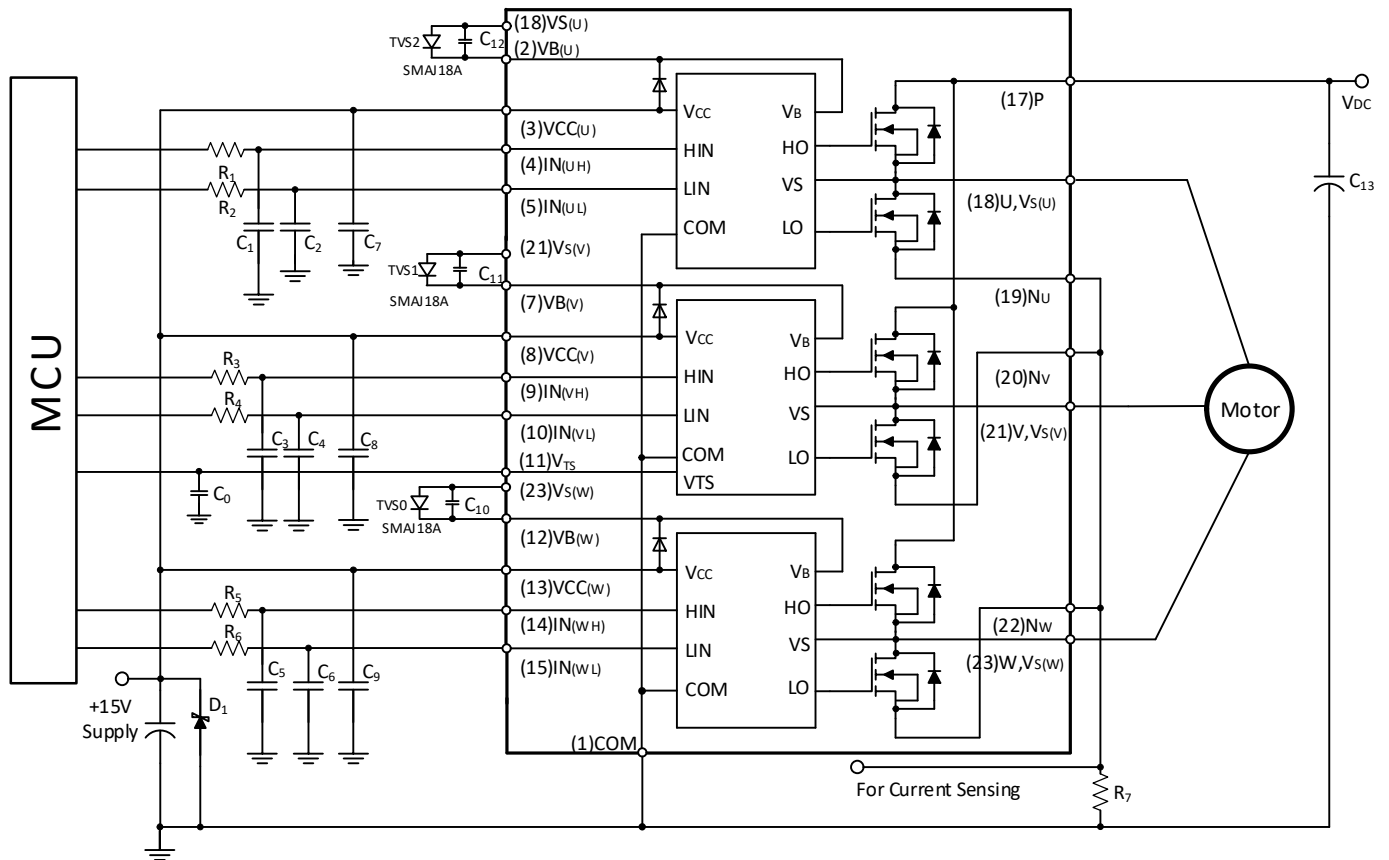


Figure8-1 Example of RC-coupling parameter 390 ohm and 1nF

### Recommended Application Circuit and MCU Interface with parameter

#### Notes:

1. RC-coupling ( $R_1 - R_6$  and  $C_0 - C_6$ ) at each input of IPM product and MCU are useful to prevent improper input signal caused by controller scheme and /or surge-noise.
2. All the filter capacitors should be connected close to IPM product, and they should have good characteristics for rejecting high-frequency ripple current.



## 9 Package Information

### SOP23 Package Outlines

