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# FSB50760SF / FSB50760SFT

## Motion SPM® 5 SuperFET® 系列

### 特性

- 通过 UL 第 E209204 号认证 (UL1557)
- 600 V  $R_{DS(on)} = 530 \text{ m}\Omega$  (最大值) SuperFET MOSFET 三相带有栅极驱动器和保护功能的 IC
- 内置自举二极管以简化印刷电路板布局
- 低端 MOSFET 的三个独立开源引脚用于三相电流感测
- 高电平有效接口, 可用于 3.3 / 5 V 逻辑电平, 施密特触发脉冲输入
- 针对低电磁干扰进行优化
- 内置于 HVIC 的温度感测
- 用于栅极驱动和欠压保护的 HVIC
- 绝缘等级: 1500 V<sub>rms</sub> / 分钟
- 符合 RoHS 标准

### 应用

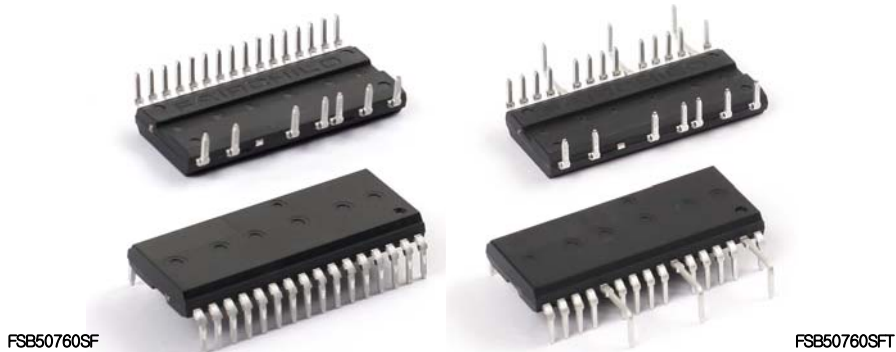
- 小功率交流电机驱动器的三相逆变器驱动

### 相关资料

- [RD-402 - Reference Design for Motion SPM 5 SuperFET Series](#)
- [AN-9082 - Motion SPM5 Series Thermal Performance by Contact Pressure](#)
- [AN-9080 - User's Guide for Motion SPM 5 Series V2](#)

### 概述

FSB50760SF/SFT 是先进的 Motion SPM® 5 模块, 为交流感应、无刷直流电机和 PMSM 电机 (如冰箱、电扇和泵) 提供非常全面的高性能逆变器输出平台。这些模块综合优化了内置 MOSFETs (SuperFET® 技术) 的栅极驱动以最小化电磁干扰和能量损耗。同时也提供多重模组保护特性, 集成欠压闭锁和热量监测。内置的高速 HVIC 只需要一个单电源电压, 将逻辑电平栅极输入转化为适合驱动模块内部 MOSFET 的高电压, 高电流驱动信号。独立的开源 MOSFET 端子在每个相位均有效, 可支持大量不同类型的控制算法。



### 封装标识与订购信息

器件	器件标识	封装	包装类型	数量
FSB50760SF	FSB50760SF	SPM5P-023	Rail	15
FSB50760SFT	FSB50760SFT	SPM5N-023	Rail	15

## 绝对最大额定值

逆变器部分 (单个 MOSFET, 除非另有说明。)

符号	参数	工作条件	额定值	单位
$V_{DSS}$	单个 MOSFET 的漏极 - 源极电压		600	V
* $I_{D25}$	单个 MOSFET 的漏极持续电流	$T_C = 25^\circ\text{C}$	3.6	A
* $I_{D80}$	单个 MOSFET 的漏极持续电流	$T_C = 80^\circ\text{C}$	2.7	A
* $I_{DP}$	单个 MOSFET 的漏极峰值电流	$T_C = 25^\circ\text{C}$ , $PW < 100 \mu\text{s}$	9.4	A
* $I_{DRMS}$	单个 MOSFET 的漏极电流有效值	$T_C = 80^\circ\text{C}$ , $F_{PWM} < 20 \text{ kHz}$	1.9	$A_{rms}$
* $P_D$	最大功耗	$T_C = 25^\circ\text{C}$ , 单个 MOSFET	14.5	W

控制部分 (单个 HVIC, 除非另有说明。)

符号	参数	工作条件	额定值	单位
$V_{CC}$	控制电源电压	施加在 $V_{CC}$ 和 COM 之间	20	V
$V_{BS}$	高端偏压	施加在 $V_B$ 和 $V_S$ 之间	20	V
$V_{IN}$	输入信号电压	施加在 $V_{IN}$ 和 COM 之间	$-0.3 \sim V_{CC} + 0.3$	V

自举二极管部分 (单个自举二极管, 除非另有说明。)

符号	参数	工作条件	额定值	单位
$V_{RRMB}$	最大重复反向电压		600	V
* $I_{FB}$	正向电流	$T_C = 25^\circ\text{C}$	0.5	A
* $I_{FPB}$	正向电流 (峰值)	$T_C = 25^\circ\text{C}$ , 脉冲宽度小于 1ms	1.5	A

## 热阻

符号	参数	工作条件	额定值	单位
$R_{\theta JC}$	结点 - 壳体的热阻	逆变器工作条件下的单个 MOSFET (注 1)	8.6	$^\circ\text{C/W}$

## 整个系统

符号	参数	工作条件	额定值	单位
$T_J$	工作结温		$-40 \sim 150$	$^\circ\text{C}$
$T_{STG}$	存储温度		$-40 \sim 125$	$^\circ\text{C}$
$V_{ISO}$	绝缘电压	60 Hz, 正弦波形, 1 分钟, 连接陶瓷基板到引脚	1500	$V_{rms}$

### 注:

- 关于壳体温度 ( $T_C$ ) 的测量点, 参见图 4。
- 标记为 "\*" 的为计算值或设计因素。

## 引脚描述

引脚号	引脚名	引脚描述
1	COM	IC 公共电源接地
2	$V_{B(U)}$	U 相高端 MOSFET 驱动的偏压
3	$V_{CC(U)}$	U 相 IC 和低端 MOSFET 驱动的偏压
4	$IN_{(UH)}$	U 相高端的信号输入
5	$IN_{(UL)}$	U 相低端的信号输入
6	N.C	无连接
7	$V_{B(V)}$	V 相高端 MOSFET 驱动的偏压
8	$V_{CC(V)}$	V 相 IC 和 低端 MOSFET 驱动的偏压
9	$IN_{(VH)}$	V 相高端的信号输入
10	$IN_{(VL)}$	V 相低端的信号输入
11	$V_{TS}$	HVIC 温度感测输出
12	$V_{B(W)}$	W 相高端 MOSFET 驱动的偏压
13	$V_{CC(W)}$	W 相 IC 和 低端 MOSFET 驱动的偏压
14	$IN_{(WH)}$	W 相高端的信号输入
15	$IN_{(WL)}$	W 相低端的信号输入
16	N.C	无连接
17	P	直流输入正端
18	U, $V_{S(U)}$	高端 MOSFET 驱动的 U 相偏压接地输出
19	$N_U$	U 相的直流输入负端
20	$N_V$	V 相的直流输入负端
21	V, $V_{S(V)}$	高端 MOSFET 驱动的 V 相偏压接地输出
22	$N_W$	W 相的直流输入负端
23	W, $V_{S(W)}$	高端 MOSFET 驱动的 W 相偏压接地输出

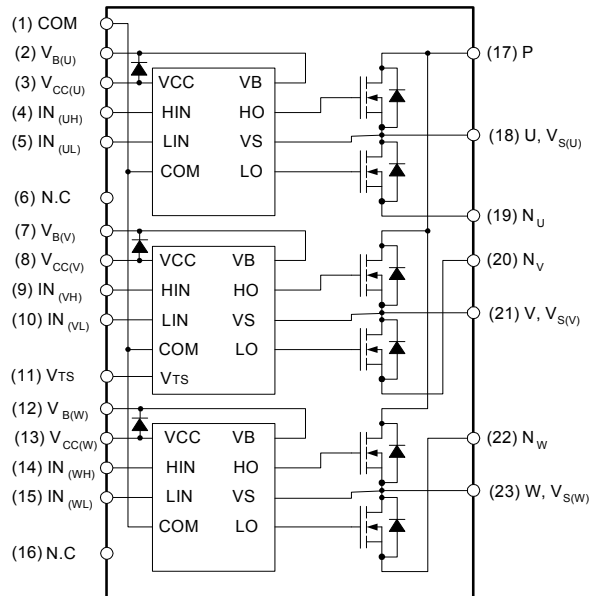


图 1. 引脚布局和内部框图 (仰视图)

注:

3. 每个低端 MOSFET 的源极端子与 Motion SPM® 5 中的电源接地或偏压接地不连接。外部连接应当如图 3 所示。

**电气特性** ( $T_J = 25^\circ\text{C}$ ,  $V_{CC} = V_{BS} = 15\text{V}$ , 除非另有说明。)**逆变器部分** (单个 MOSFET, 除非另有说明。)

符号	参数	工作条件	最小值	典型值	最大值	单位
$BV_{DSS}$	漏极 - 源极击穿电压	$V_{IN} = 0\text{V}$ , $I_D = 1\text{mA}$ (注 1)	600	-	-	V
$I_{DSS}$	零栅极电压漏极电流	$V_{IN} = 0\text{V}$ , $V_{DS} = 600\text{V}$	-	-	1	mA
$R_{DS(on)}$	漏极至源极静态导通电阻	$V_{CC} = V_{BS} = 15\text{V}$ , $V_{IN} = 5\text{V}$ , $I_D = 2\text{A}$	-	460	530	m $\Omega$
$V_{SD}$	漏极 - 源极二极管正向电压	$V_{CC} = V_{BS} = 15\text{V}$ , $V_{IN} = 0\text{V}$ , $I_D = -2\text{A}$	-	-	1.1	V
$t_{ON}$	开关时间	$V_{PN} = 300\text{V}$ , $V_{CC} = V_{BS} = 15\text{V}$ , $I_D = 2\text{A}$ $V_{IN} = 0\text{V} \leftrightarrow 5\text{V}$ , 电感负载 $L = 3\text{mH}$ 高端和低端 MOSFET 开关 (注 2)	-	1200	-	ns
$t_{OFF}$			-	970	-	ns
$t_{rr}$			-	160	-	ns
$E_{ON}$			-	120	-	$\mu\text{J}$
$E_{OFF}$			-	10	-	$\mu\text{J}$
RBSOA	反向偏压安全工作区	$V_{PN} = 400\text{V}$ , $V_{CC} = V_{BS} = 15\text{V}$ , $I_D = I_{DP}$ , $V_{DS} = BV_{DSS}$ , $T_J = 150^\circ\text{C}$ 高端和低端 MOSFET 开关 (注 3)	整个区域			

**控制部分** (单个 HVIC, 除非另有说明。)

符号	参数	工作条件	最小值	典型值	最大值	单位
$I_{QCC}$	$V_{CC}$ 静态电流	$V_{CC} = 15\text{V}$ , $V_{IN} = 0\text{V}$ 施加在 $V_{CC}$ 和 COM 之间	-	-	200	$\mu\text{A}$
$I_{QBS}$	$V_{BS}$ 静态电流	$V_{BS} = 15\text{V}$ , $V_{IN} = 0\text{V}$ 施加在 $V_{B(U)} - U$ , $V_{B(V)} - V$ , $V_{B(W)} - W$	-	-	100	$\mu\text{A}$
$UV_{CCD}$	低端欠压保护 (图 8)	$V_{CC}$ 欠压保护检测电平	7.4	8.0	9.4	V
$UV_{CCR}$		$V_{CC}$ 欠压保护复位电平	8.0	8.9	9.8	V
$UV_{BSD}$	高端欠压保护 (图 9)	$V_{BS}$ 欠压保护检测电平	7.4	8.0	9.4	V
$UV_{BSR}$		$V_{BS}$ 欠压保护复位电平	8.0	8.9	9.8	V
$V_{TS}$	HVIC 温度感测电压输出	$V_{CC} = 15\text{V}$ , $T_{HVIC} = 25^\circ\text{C}$ (注 4)	600	790	980	mV
$V_{IH}$	导通阈值电压	逻辑高电平 施加在 $V_{IN}$ 和 COM 之间	-	-	2.9	V
$V_{IL}$	关断阈值电压	逻辑低电平	0.8	-	-	V

**自举二极管部分** (单个自举二极管, 除非另有说明。)

符号	参数	工作条件	最小值	典型值	最大值	单位
$V_{FB}$	正向电压	$I_F = 0.1\text{A}$ , $T_C = 25^\circ\text{C}$ (注 5)	-	2.5	-	V
$t_{rB}$	反向恢复时间	$I_F = 0.1\text{A}$ , $T_C = 25^\circ\text{C}$	-	80	-	ns

**注:**

- $BV_{DSS}$  是 Motion SPM® 5 产品中的单个 MOSFET 的漏极和源极端子之间的绝对最大额定电压。考虑到寄生电感,  $V_{PN}$  应远低于该值, 因此  $V_{PN}$  在任何情况下不得超过  $BV_{DSS}$ 。
- $t_{ON}$  和  $t_{OFF}$  包括内部驱动 IC 的传输延迟。所列出的数值是在实验室测试条件下测得, 在实际应用中因为印刷电路板和布线的差异, 数值也会有所不同。请参阅图 6 介绍的开关时间定义, 以及图 7 中的开关测试电路。
- 每个 MOSFET 在开关工作时的峰值电流和电压也应在安全工作区 (SOA) 的范围内。请参阅图 7 中的 RBSOA 测试电路, 它与开关测试电路相同。
- $V_{IS}$  只能用作模块的温度感测, 但不能自动关闭 MOSFETs。
- 内置自举二极管其阻抗特性约为  $15\Omega$ 。请参阅图 2。

## 推荐工作条件

符号	参数	工作条件	最小值	典型值	最大值	单位
$V_{PN}$	电源电压	施加在 P 和 N 之间	-	300	400	V
$V_{CC}$	控制电源电压	施加在 $V_{CC}$ 和 COM 之间	13.5	15.0	16.5	V
$V_{BS}$	高端偏压	施加在 $V_B$ 和 $V_S$ 之间	13.5	15.0	16.5	V
$V_{IN(ON)}$	输入导通阈值电压	施加在 $V_{IN}$ 和 COM 之间	3.0	-	$V_{CC}$	V
$V_{IN(OFF)}$	输入关断阈值电压		0	-	0.6	V
$t_{dead}$	防止桥臂直通的死区时间	$V_{CC} = V_{BS} = 13.5 \sim 16.5 \text{ V}$ , $T_J \leq 150^\circ\text{C}$	1.0	-	-	$\mu\text{s}$
$f_{PWM}$	PWM 开关频率	$T_J \leq 150^\circ\text{C}$	-	20	-	kHz

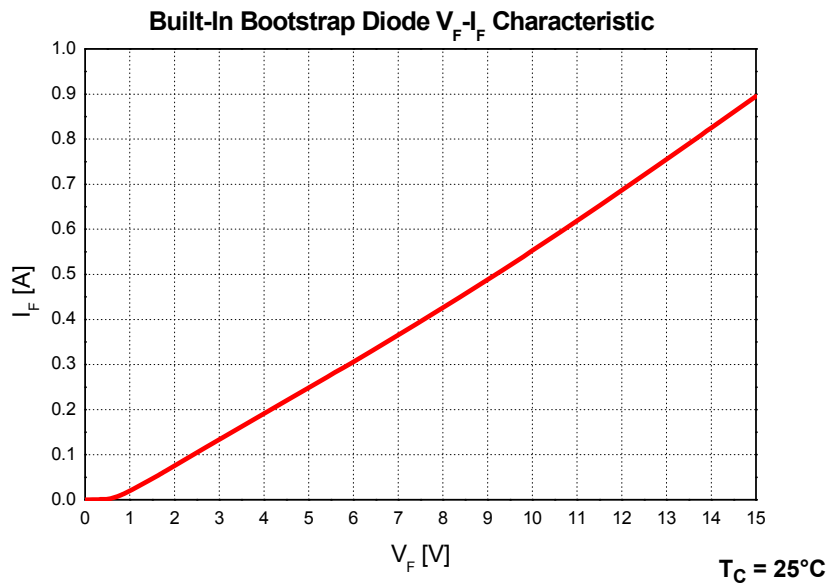
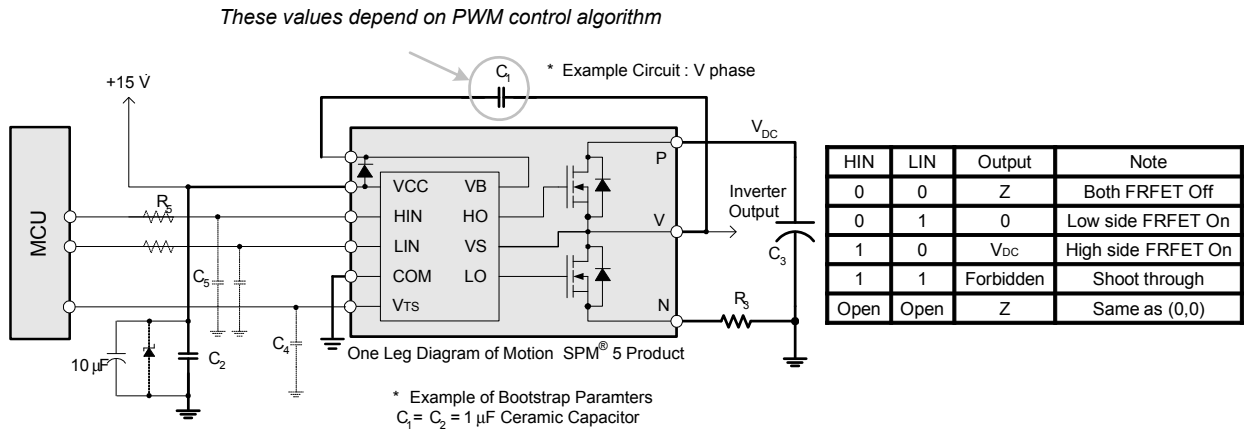


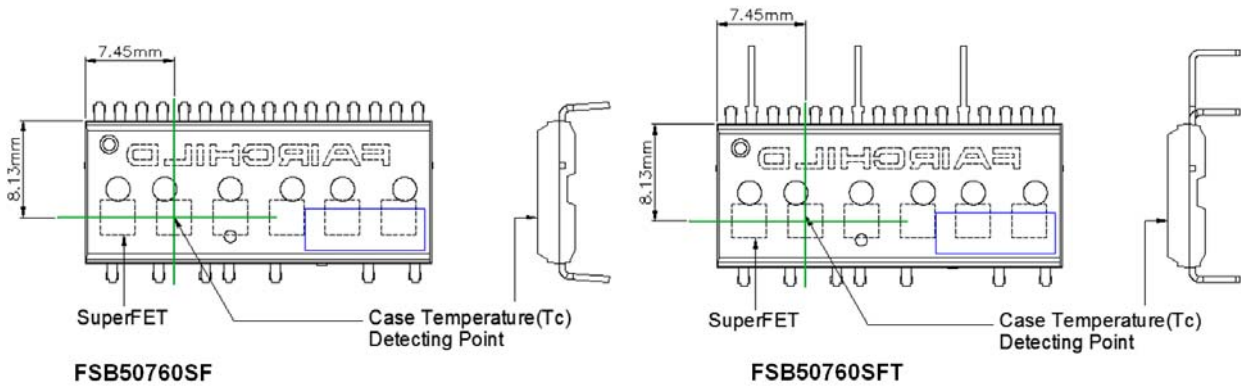
图 2. 内置自举二极管特性 (典型值)



**图 3. 推荐的 MCU 接口和自举电路及其参数**

注:

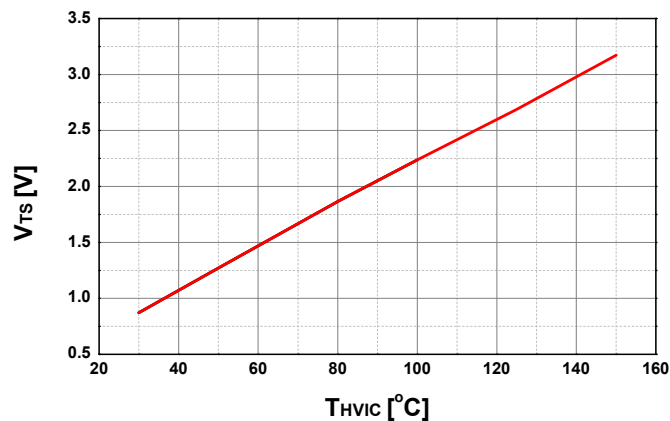
1. 自举电路的参数取决于 PWM 算法。上述为开关频率为 15 kHz 时的参数的典型例子。
2. Motion SPM 5 产品和 MCU (虚线显示部分) 的每个输入端的 RC 耦合 (R<sub>5</sub> 和 C<sub>5</sub>) 和 C<sub>4</sub>, 可用于防止由浪涌噪声产生的错误信号
3. 印刷电路板图形中的粗线应尽量短且粗, 以减少电路中的寄生电感, 从而导致浪涌电压的降低。旁路电容 C<sub>1</sub>, C<sub>2</sub> 和 C<sub>3</sub> 应具有良好的高频特性, 以吸收高频纹波电流。



**图 4. 壳体温度测量**

注:

4. 将热电偶贴在 SPM 5 封装 (如果应用到, 放在 SPM 5 封装和散热片中间) 的散热片的顶部, 以获得正确的温度测量数值。



**图 5. V<sub>TS</sub> 的温度曲线 (典型值)**

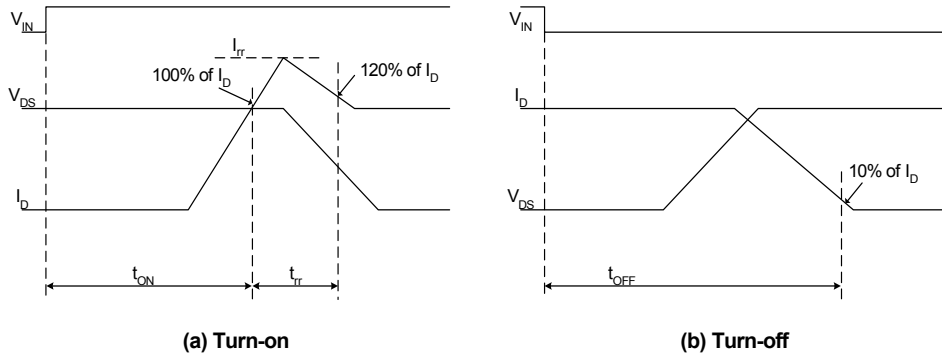


图 6. 开关时间定义

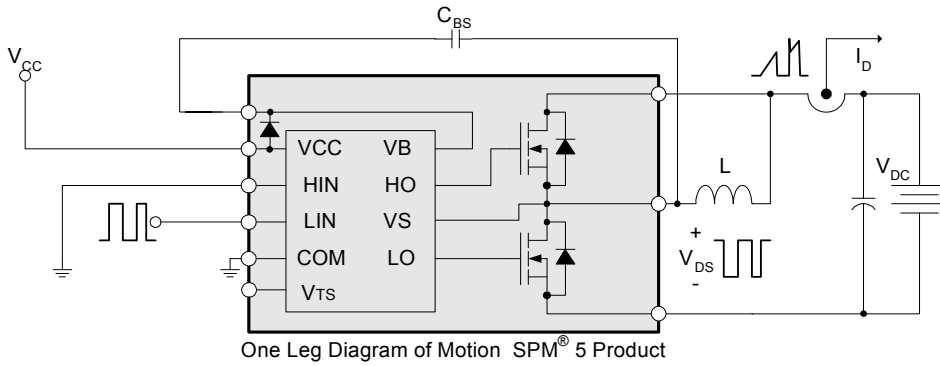


图 7. 开关和 RBSOA (单脉冲) 测试电路 (低端)

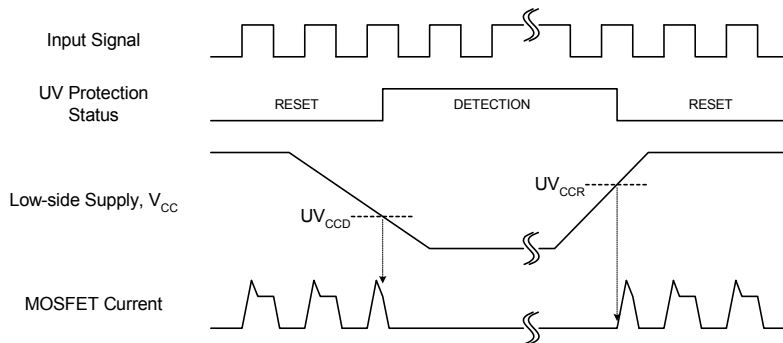


图 8. 欠压保护 (低端)

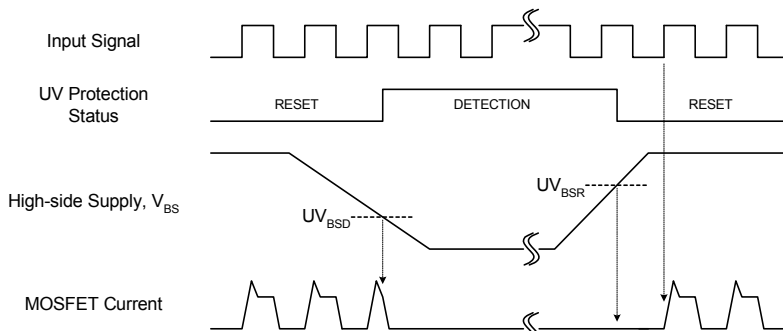


图 9. 欠压保护 (高端)



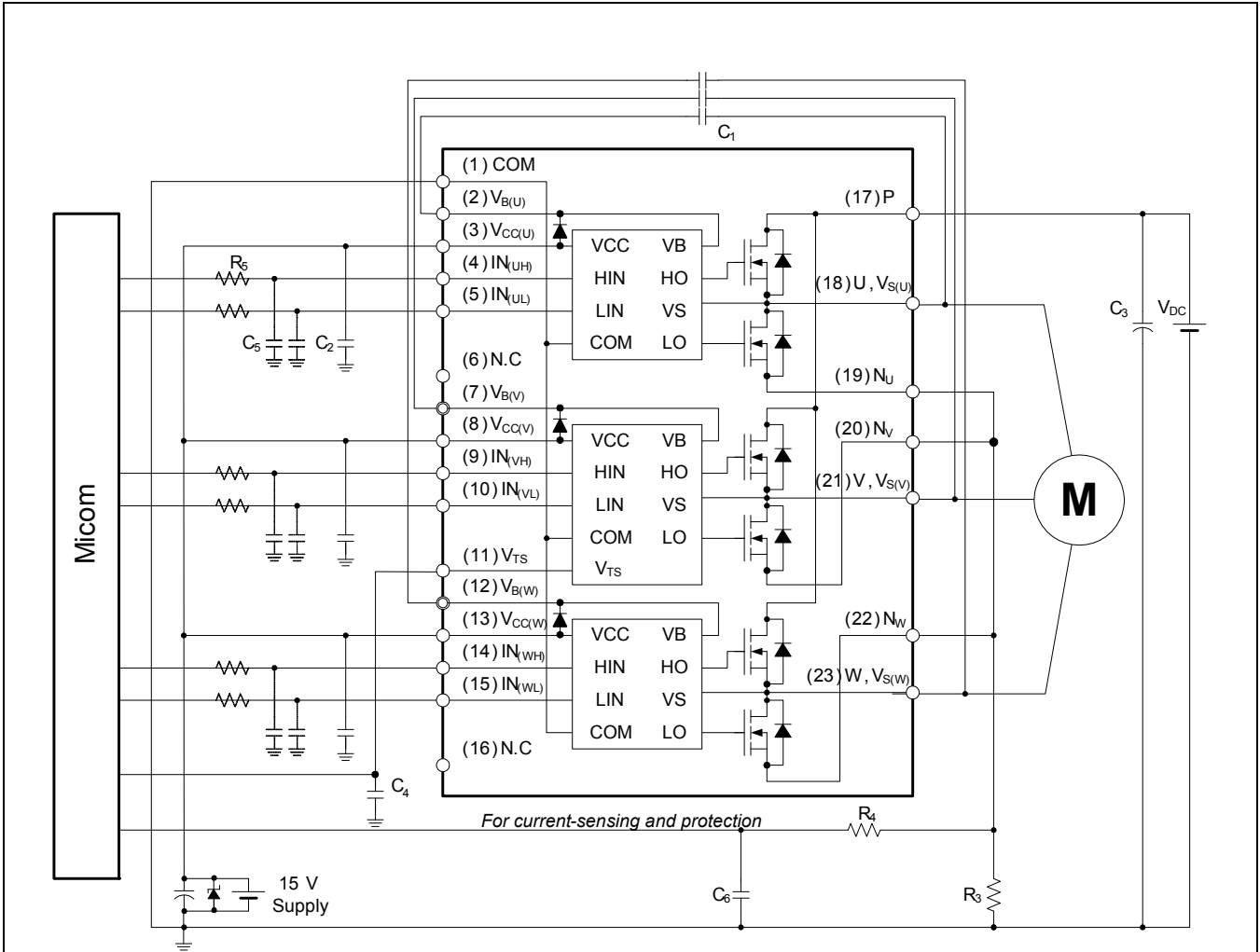
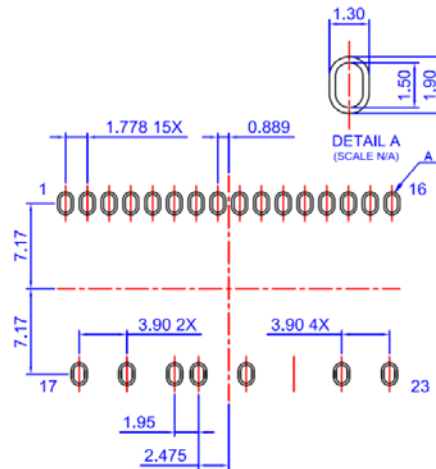
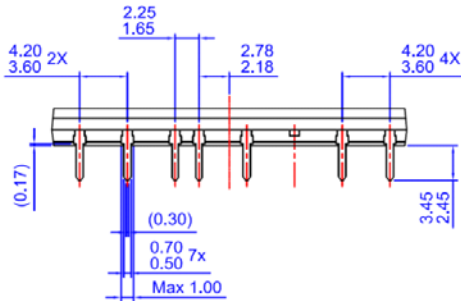
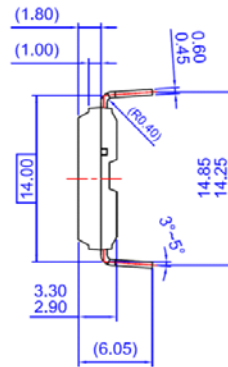
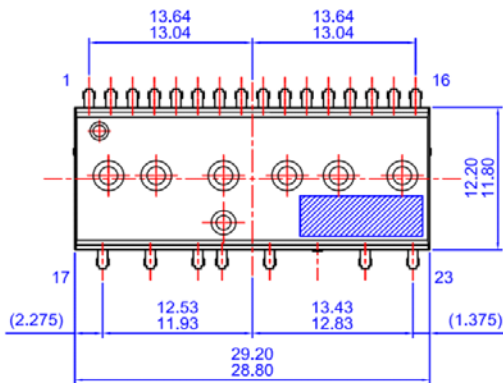
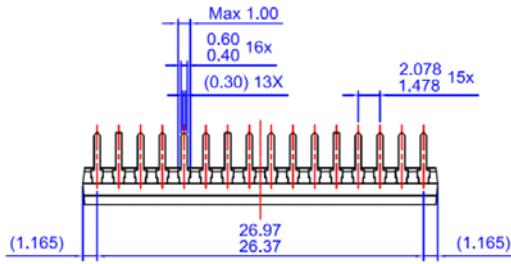


图 10. 应用电路实例

注:

1. 关于引脚的位置, 请参阅图 1。
2. Motion SPM® 5 产品和 MCU 的每个输入端的 RC 耦合 ( $R_5$  和  $C_5$ ,  $R_4$  和  $C_6$ ) 和  $C_4$ , 能有效的防止由浪涌噪声产生的错误的输入信号。
3. 由于位于 COM 和低端 MOSFET 的源极端子之间,  $R_3$  的压降会影响低端的开关性能和自举特性。为此, 稳态情况下  $R_3$  的压降应小于 1 V。
4. 为避免浪涌电压和 HVIC 故障, 接地线和输出端子之间的接线应短且粗。
5. 所有的滤波电容器应紧密连接到 Motion SPM 5 产品, 它们应当具有能够很好的阻挡高频纹波电流的特性。

### 封装轮廓详图 (FSB50760SF)



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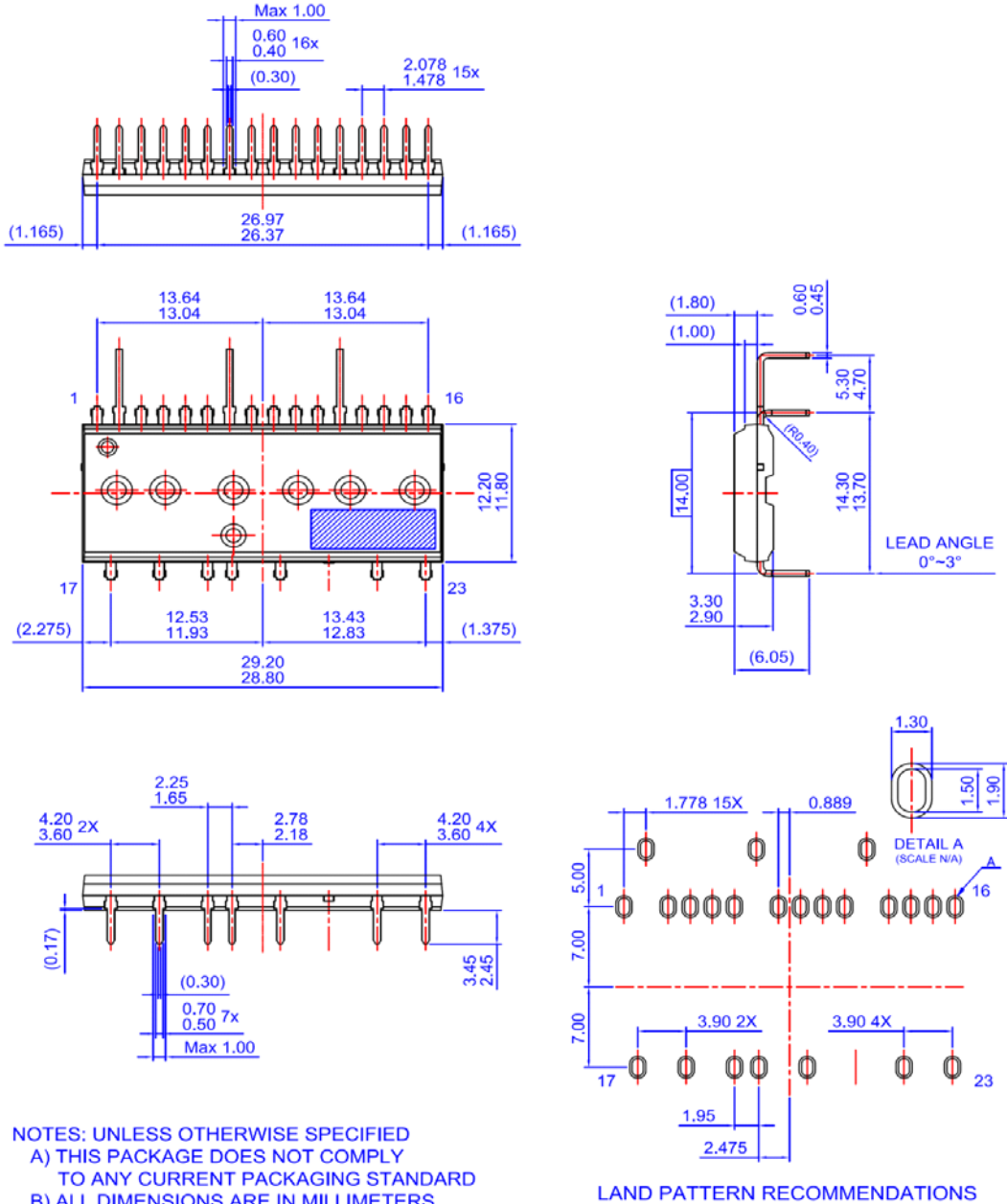
LAND PATTERN RECOMMENDATIONS

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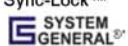



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