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FSB50660SF / FSB50660SFT

Motion SPM® 5 SuperFET® 系列

特性

- 通过 UL 第 E209204 号认证 (UL1557)
- 600 V $R_{DS(on)} = 700 \text{ m}\Omega$ (最大值) SuperFET MOSFET 三相逆变器, 带有栅极驱动器和保护功能
- 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_{rms} / 分钟
- 符合 RoHS 标准

应用

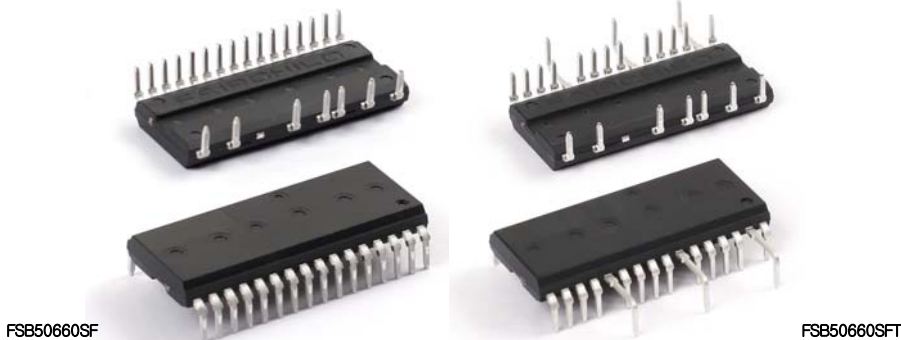
- 小功率交流电机驱动器的三相逆变器驱动

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

FSB50660SF/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, 可支持大量不同种类的控制算法。



封装标识与订购信息

器件	器件标识	封装	包装类型	数量
FSB50660SF	FSB50660SF	SPM5P-023	Rail	15
FSB50660SFT	FSB50660SFT	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	$T_C = 25^\circ\text{C}$	3.1	A
$*I_{D80}$	单个 MOSFET 的漏极持续电流	$T_C = 80^\circ\text{C}$	2.3	A
$*I_{DP}$	单个 MOSFET 的漏极峰值电流	$T_C = 25^\circ\text{C}$, $PW < 100 \mu\text{s}$	8.1	A
$*I_{DRMS}$	单个 MOSFET 的漏极电流有效值	$T_C = 80^\circ\text{C}$, $F_{PWM} < 20 \text{ kHz}$	1.6	A_{rms}
$*P_D$	最大功耗	$T_C = 25^\circ\text{C}$, 单个 MOSFET	14.2	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)	8.8	$^\circ\text{C/W}$

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 2。
- 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

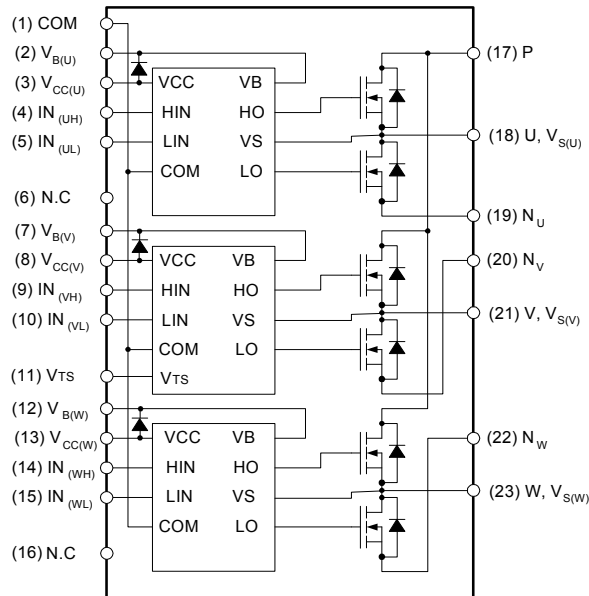


图 1. 引脚布局和内部框图 (仰视图)

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	$V_{CC} = V_{BS} = 15\text{V}$, $V_{IN} = 5\text{V}$, $I_D = 1.5\text{A}$	-	600	700	m Ω
V_{SD}	漏极 - 源极二极管正向电压	$V_{CC} = V_{BS} = 15\text{V}$, $V_{IN} = 0\text{V}$, $I_D = -1.5\text{A}$	-	-	1.1	V
t_{ON}	开关时间	$V_{PN} = 300\text{V}$, $V_{CC} = V_{BS} = 15\text{V}$, $I_D = 1.5\text{A}$ $V_{IN} = 0\text{V} \leftrightarrow 5\text{V}$, 电感负载 $L = 3\text{mH}$ 高端和低端 MOSFET 开关 (注 2)	-	950	-	ns
t_{OFF}			-	820	-	ns
t_r			-	120	-	ns
E_{ON}			-	130	-	μJ
E_{OFF}			-	5	-	μJ
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_{OCC}	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	μA
I_{OBS}	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	μA
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	-	-	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
- 内置自举二极管的电阻约为 15Ω 。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	-	-	μs
f_{PWM}	PWM 开关频率	$T_J \leq 150^\circ\text{C}$	-	20	-	kHz

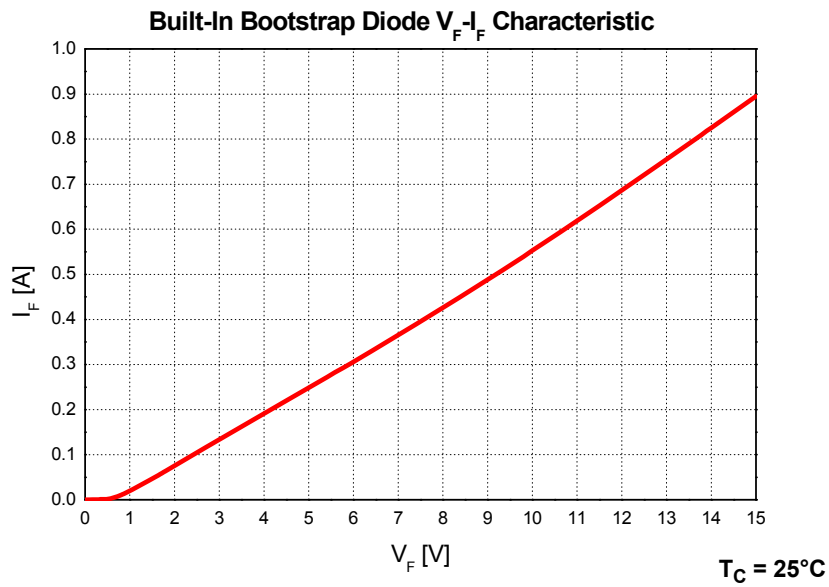


图 2. 内置自举二极管特性 (典型值)

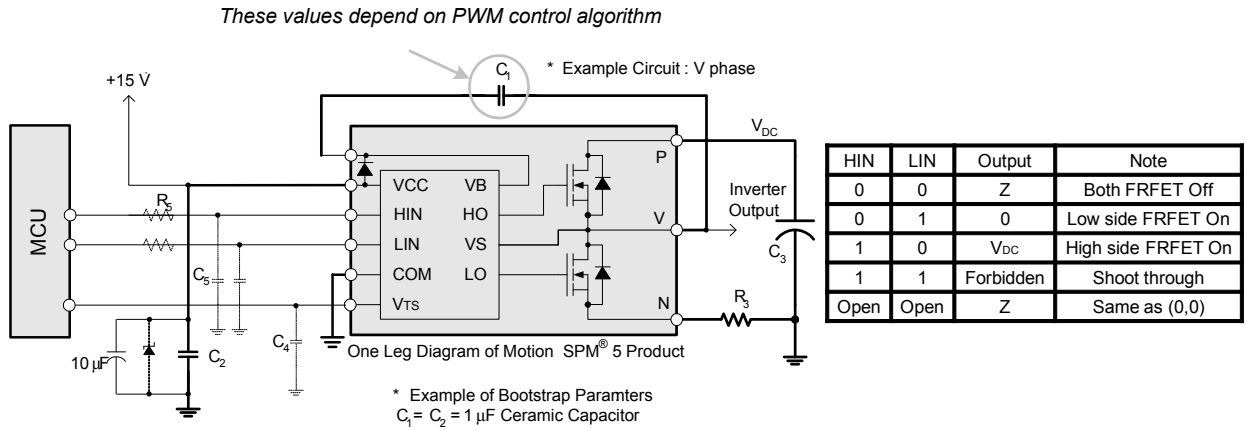


图 3. 推荐的 MCU 接口和自举电路及其参数

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（R₅ 和 C₅）和 C₄，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 C₁、C₂ 和 C₃ 应具有良好的高频特性，以吸收高频纹波电流。

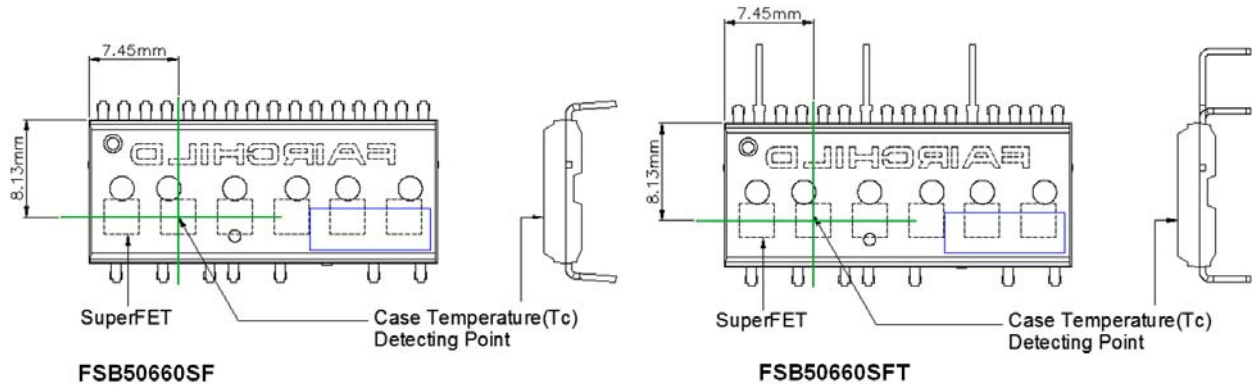


图 4. 壳体温度测量

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。

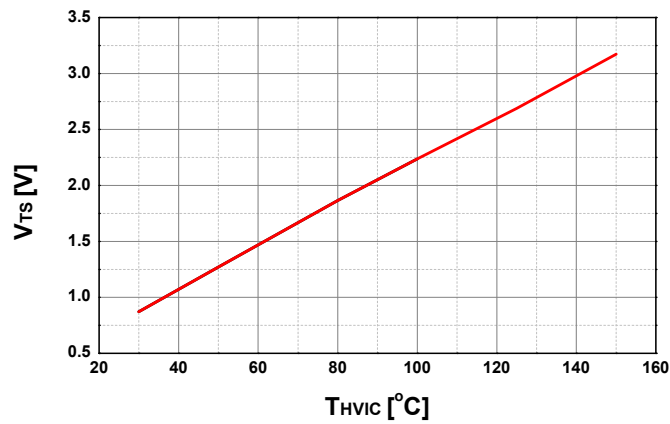


图 5. V_{TS} 的温度曲线（典型值）

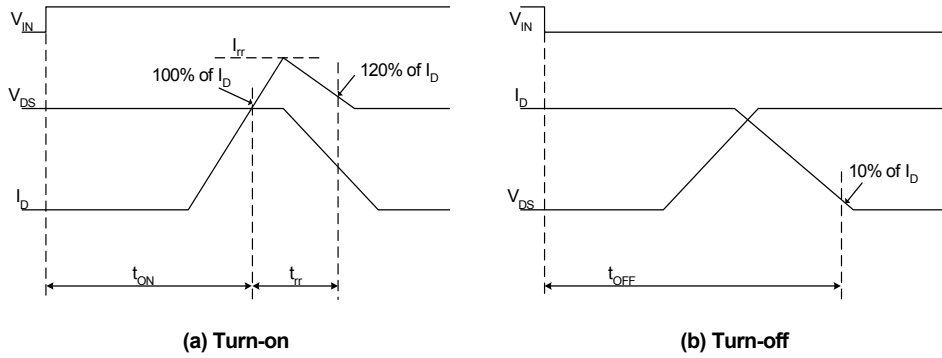


图 6. 开关时间定义

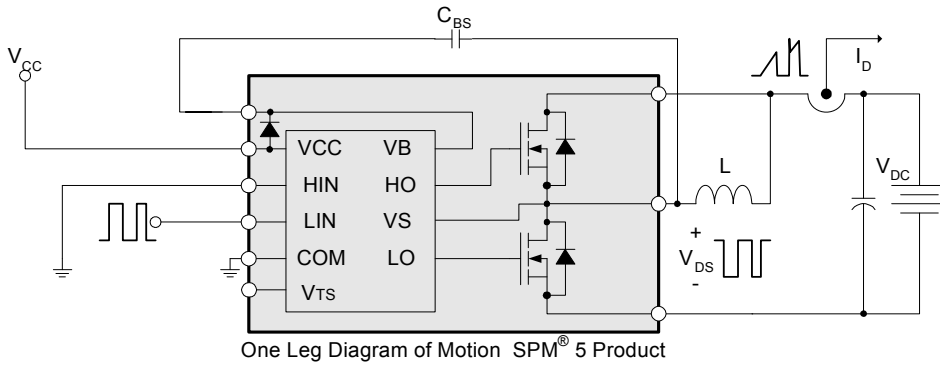


图 7. 开关和 RBSOA (单脉冲) 测试电路 (低端)

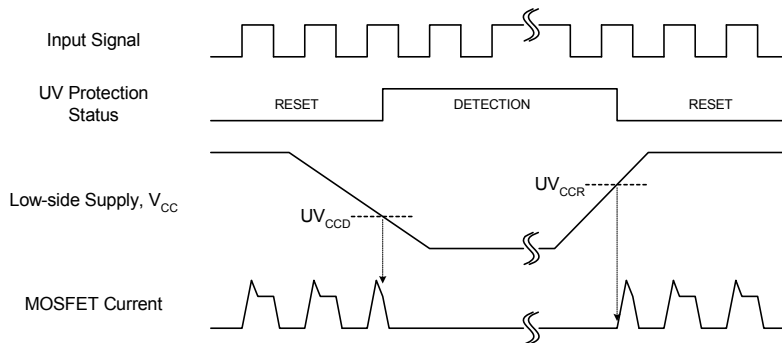


图 8. 欠压保护 (低端)

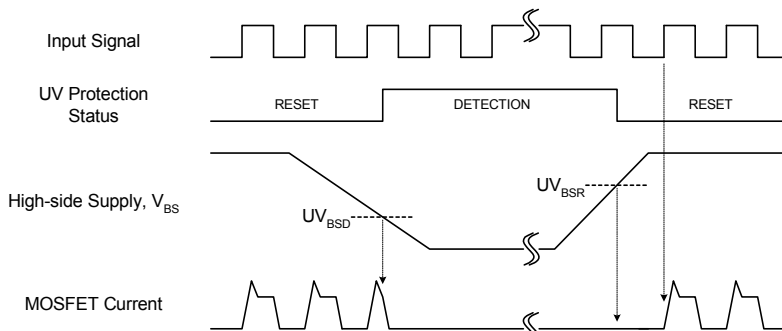


图 9. 欠压保护 (高端)

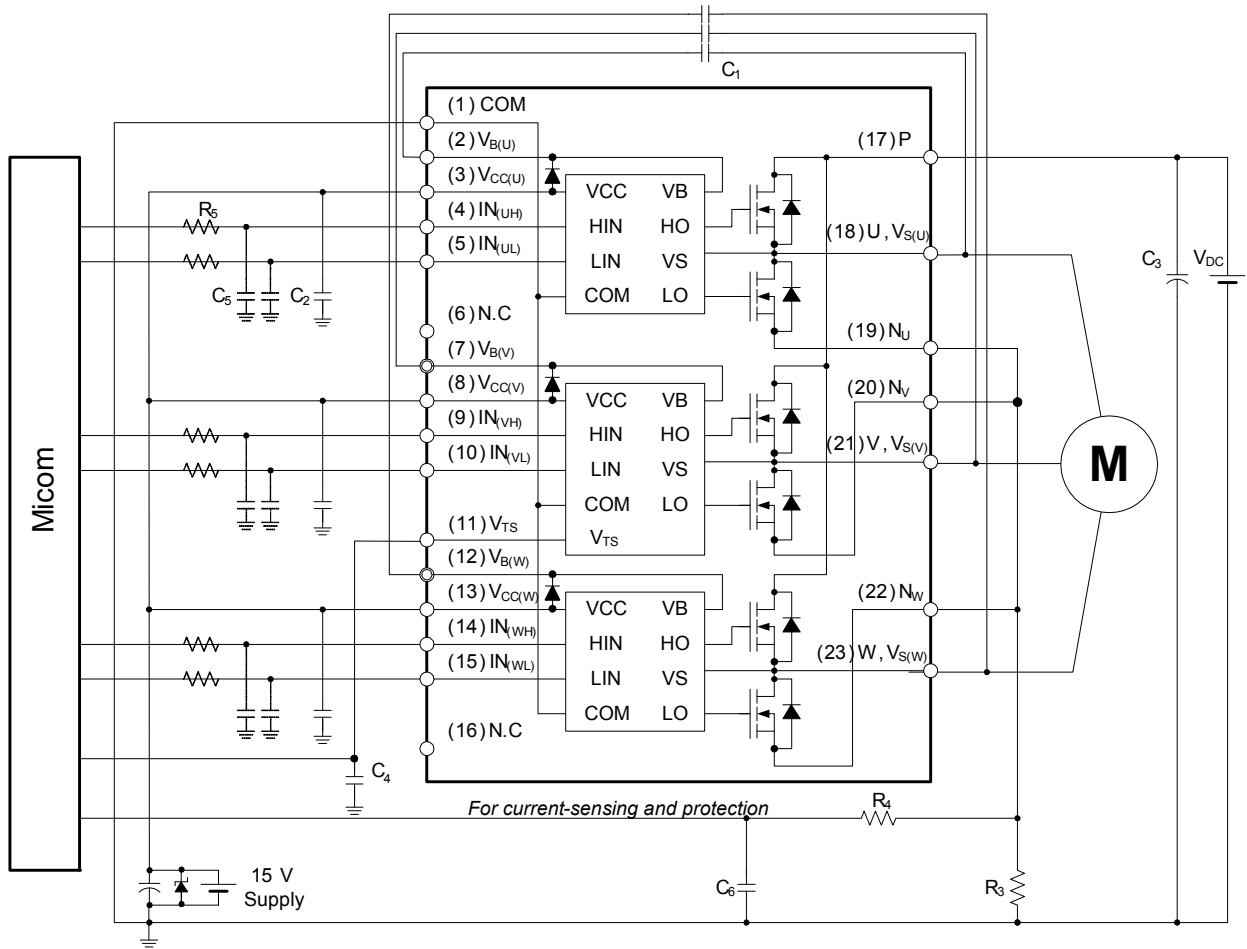
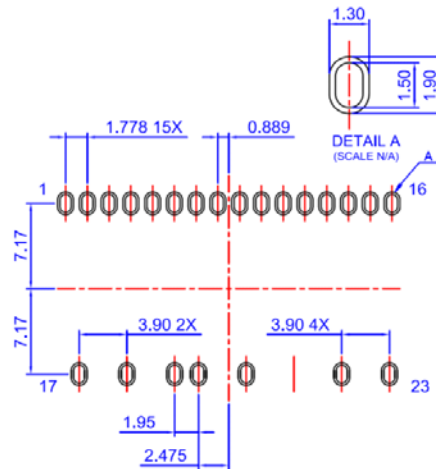
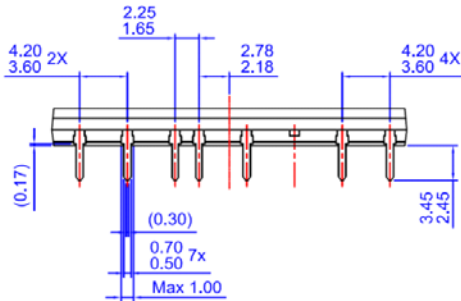
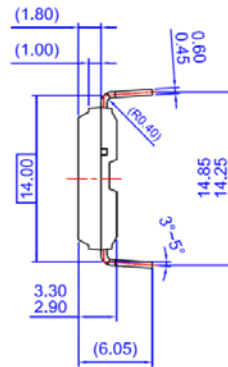
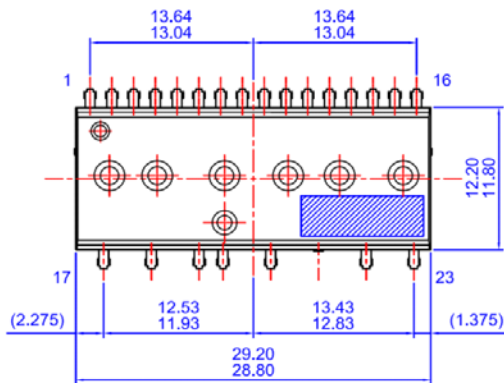
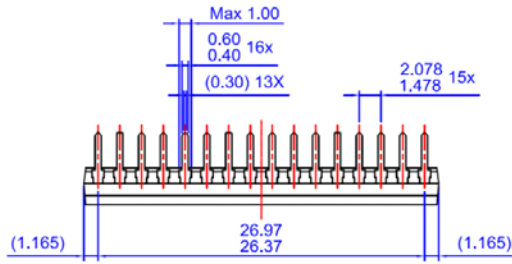


图 10. 应用电路实例

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 (FSB50660SF)



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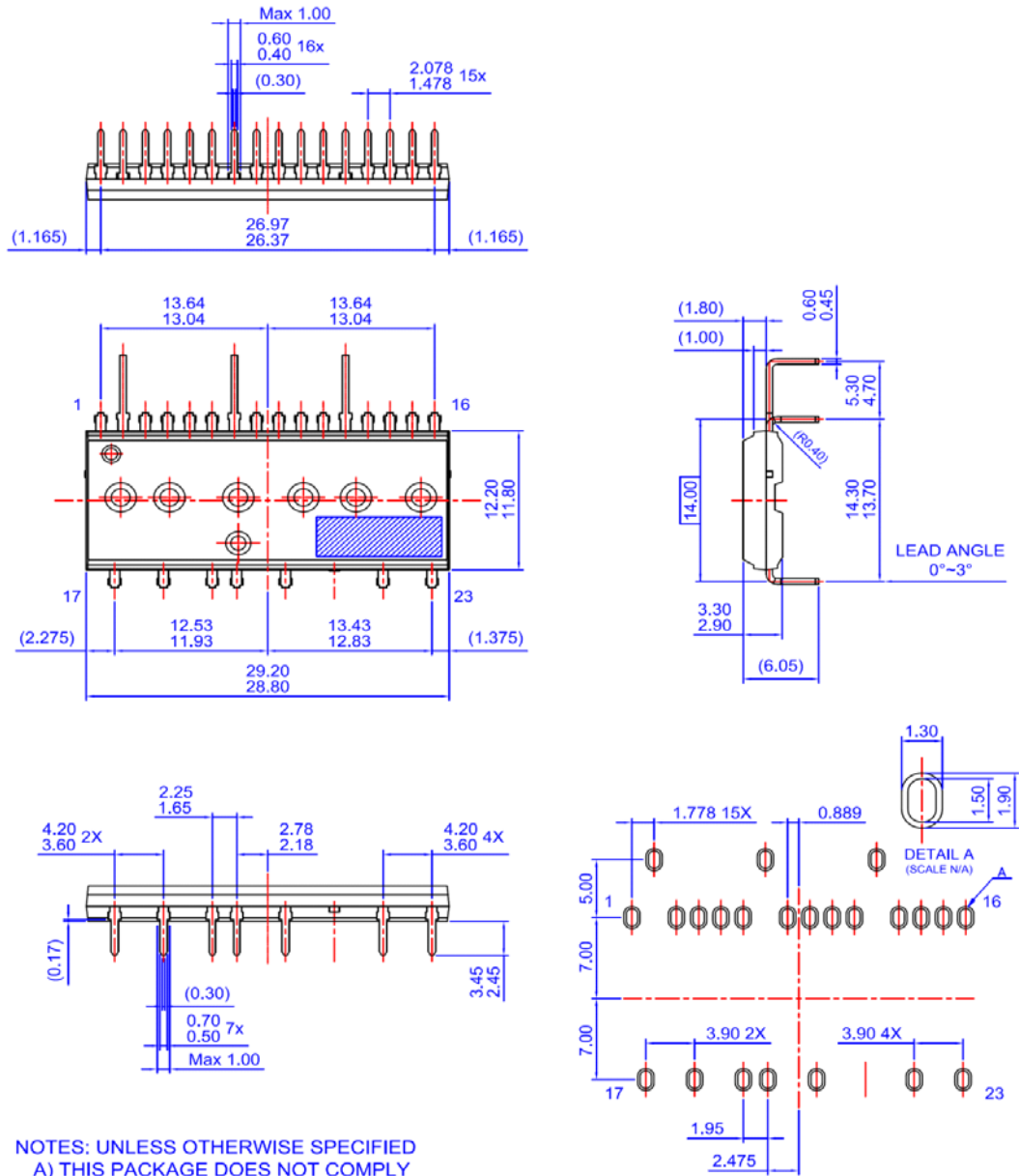
LAND PATTERN RECOMMENDATIONS

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