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2015 年 12 月

FSB70250 Motion SPM[®] 7 系列

特性

- 通过 UL 第 E209204 号认证 (UL1557)
- 高性能 PQFN 封装
- 500 V $R_{DS(on)} = 3.4 \Omega$ (最大值) FRFET MOSFET 三相逆变器, 带有栅极驱动器和保护功能
- 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, 互锁功能和欠压保护的 HVIC
- 绝缘等级: 1500 V_{rms} / 分钟
- 湿度敏感等级 (MSL) 3
- 符合 RoHS 标准

应用

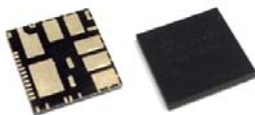
- 小功率交流电机驱动器的三相逆变器驱动

相关资料

- [AN-9077 - Motion SPM[®] 7 Series User's Guide](#)
- [AN-9078 - Surface Mount Guidelines for Motion SPM[®] 7 Series](#)

概述

FSB70250 是一款先进的 Motion SPM[®] 7 模块, 为交流感应、无刷直流电机和 PMSM 电机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 (FRFET[®] 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, 热量监测, 故障报告和互锁功能。内置的一个 HVIC 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

器件标识	器件	封装	卷尺寸	卷带宽度	数量
FSB70250	FSB70250	PQFN27A	13"	24 mm	1000 个

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		500	V
$*I_{D25}$	单个 MOSFET 的漏极持续电流	$T_{CB} = 25^{\circ}\text{C}$ (注 1)	3.3	A
$*I_{D80}$	单个 MOSFET 的漏极持续电流	$T_{CB} = 80^{\circ}\text{C}$	2.5	A
$*I_{DP}$	单个 MOSFET 的漏极峰值电流	$T_{CB} = 25^{\circ}\text{C}$, $PW < 100 \mu\text{s}$	6.7	A
$*P_D$	最大功耗	$T_{CB} = 25^{\circ}\text{C}$, 单个 MOSFET	81	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_{DD}	控制电源电压	施加在 V_{DD} 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 IN 和 COM 之间	$-0.3 \sim V_{DD} + 0.3$	V
V_{FO}	故障输出电源电压	施加在 FO 和 COM 之间	$-0.3 \sim V_{DD} + 0.3$	V
I_{FO}	故障输出电流	灌电流 FO 引脚	5	mA
V_{CSC}	电流感测输入电压	施加在 Csc 和 COM 之间	$-0.3 \sim V_{DD} + 0.3$	V

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:

- T_{CB} 是壳体底部的垫片温度。
- 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	/FO	故障输出
2	V_{TS}	以电压形式输出的 HVIC 温度
3	Cfod	用于故障输出持续时间的电容
4	Csc	短路电流感测输入电容（低通滤波器）
5	V_{DD}	驱动 IC 和 MOSFET 的电源偏置电压
6	IN_UH	高端 U 相的信号输入
7	IN_VH	高端 V 相的信号输入
8 (8a)	COM	公共电源接地
9	IN_WH	高端 W 相的信号输入
10	IN_UL	低端 U 相的信号输入
11	IN_VL	低端 V 相的信号输入
12	IN_WL	低端 W 相的信号输入
13	Nu	U 相的直流输入负端
14	U	U 相输出
15	Nv	V 相的直流输入负端
16	V	V 相输出
17	W	W 相输出
18	Nw	W 相的直流输入负端
19	$V_{S(W)}$	W 相 MOSFET 驱动的高端偏压接地
20	P_W	W 相的直流输入正端
21	P_V	V 相的直流输入正端
22	P_U	U 相的直流输入正端
23 (23a)	$V_{S(V)}$	V 相 MOSFET 驱动的高端偏压接地
24 (24a)	$V_{S(U)}$	U 相 MOSFET 驱动的高端偏压接地
25	$V_{B(U)}$	U 相 MOSFET 驱动的高端偏压
26	$V_{B(V)}$	V 相 MOSFET 驱动的高端偏压
27	$V_{B(W)}$	W 相 MOSFET 驱动的高端偏压

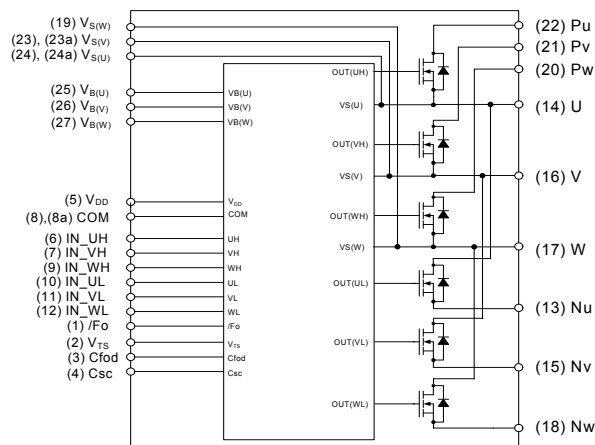


图 1. 引脚布局和内部框图

注:

- 每个低端 MOSFET 的源极端子与 Motion SPM® 7 中的电源接地或偏压接地不连接。外部连接应当如图 2 所示。
- 后缀为 -a 的垫片连接到相同数字的引脚，例如：8 和 8a 在内部连接在一起。

电气特性 ($T_J = 25^\circ\text{C}$, $V_{DD} = V_{BS} = 15\text{ V}$ 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)	500	-	-	V
I_{DSS}	零栅极电压漏极电流	$V_{IN} = 0\text{ V}$, $V_{DS} = 500\text{ V}$	-	-	1	mA
$R_{DS(on)}$	漏极至源极静态导通电阻	$V_{DD} = V_{BS} = 15\text{ V}$, $V_{IN} = 5\text{ V}$, $I_D = 1.0\text{ A}$	-	2.5	3.4	Ω
V_{SD}	漏极-源极二极管正向电压	$V_{DD} = V_{BS} = 15\text{ V}$, $V_{IN} = 0\text{ V}$, $I_D = -1.0\text{ A}$	-	0.9	1.2	V
t_{ON}	开关时间	$V_{PN} = 300\text{ V}$, $V_{DD} = V_{BS} = 15\text{ V}$, $I_D = 1.0\text{ A}$ $V_{IN} = 0\text{ V} \leftrightarrow 5\text{ V}$, 电感负载 $L = 3\text{ mH}$ 低端 MOSFET 开关 (注 2)	-	720	-	ns
$t_{D(ON)}$			-	660	-	ns
t_{OFF}			-	520	-	ns
$t_{D(OFF)}$			-	460	-	ns
I_{rr}			-	1.1	-	A
t_{rr}			-	145	-	ns
E_{ON}			-	75	-	μJ
E_{OFF}			-	7	-	μJ

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_{QDD}	V_{DD} 静态电流	$V_{DD}=15\text{ V}$, $V_{IN}=0\text{ V}$	$V_{DD} - \text{COM}$	-	1.7	3.0	mA
I_{QBS}	V_{BS} 静态电流	$V_{BS}=15\text{ V}$, $V_{IN}=0\text{ V}$	$V_{B(X)} - V_{S(X)}$, $V_{B(V)} - V_{S(V)}$, $V_{B(W)} - V_{S(W)}$	-	45	70	μA
I_{PDD}	V_{DD} 工作电流	$V_{DD}=15\text{ V}$, $F_{PWM}=20\text{ kHz}$, duty=50%, PWM 信号低端 输入	$V_{DD} - \text{COM}$	-	1.9	3.2	mA
I_{PBS}	V_{BS} 工作电流	$V_{BS}=15\text{ V}$, $F_{PWM}=20\text{ kHz}$, duty=50%, PWM 信号高端 输入	$V_{B(U)} - V_{S(U)}$, $V_{B(V)} - V_{S(V)}$, $V_{B(W)} - V_{S(W)}$	-	300	400	μA
UV_{DDD}	低端欠压保护 (图 6)	V_{DD} 欠压保护检测电平	7.4	8.0	9.4	V	
UV_{DDR}		V_{DD} 欠压保护复位电平	8.0	8.9	9.8	V	
UV_{BSD}	高端欠压保护 (图 7)	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	$V_{DD}=15\text{ V}$, $T_{HVIC}=25^\circ\text{C}$ (注 3)	580	675	770	mV	
V_{IH}	导通阈值电压	逻辑高电平	IN - COM	-	-	2.4	V
V_{IL}	关断阈值电压	逻辑低电平		0.8	-	-	V
$V_{SC(ref)}$	短路电流保护触发电平	$V_{DD}=15\text{ V}$	$C_{SC} - \text{COM}$	0.45	0.5	0.55	V
t_{FOD}	故障输出脉宽	$C_{FOD}=33\text{ nF}$ (注 4)	1.0	1.4	1.8	ms	

注:

- BV_{DSS} 是 Motion SPM® 7 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 3 介绍的开关时间定义, 以及图 4 中的开关测试电路。
- V_{IS} 只能用作模块的温度感测, 但不能自动关闭 MOSFETs。
- 故障输出脉宽 t_{FOD} 取决于电容 C_{FOD} 的值, 可采用下面的近似公式进行计算: $C_{FOD} = 24 \times 10^{-6} \times t_{FOD} [\text{F}]$

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_{DD}	控制电源电压	施加在 V_{DD} 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
dV_{DD}/dt , dV_{BS}/dt	控制电源波动		-1.0	-	1.0	V/ μ s
t_{dead}	防止桥臂直通的死区时间	$V_{DD} = V_{BS} = 13.5 \sim 16.5$ V, $T_J \leq 150^\circ\text{C}$	500	-	-	ns
f_{PWM}	PWM 开关频率	$T_J \leq 150^\circ\text{C}$	-	15	-	kHz

热阻

符号	参数	工作条件	最小值	典型值	最大值	单位
$R_{\theta JCB}$	结点 - 壳体底部的热阻	单个 MOSFET 工作条件下 (注 1)	-	1.2	-	$^\circ\text{C}/\text{W}$

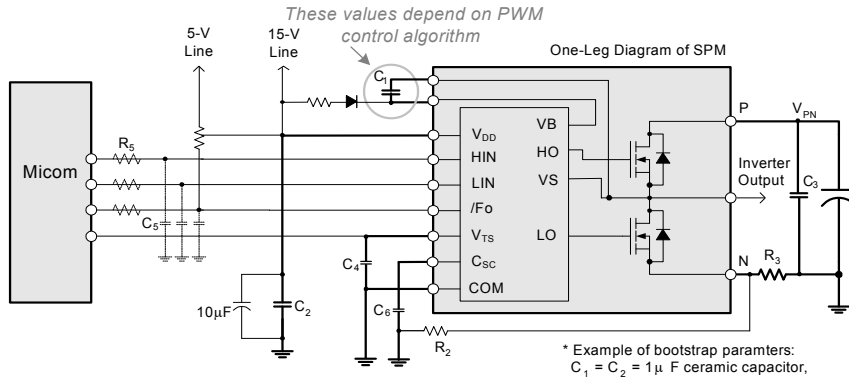


图 2. 推荐的 MCU 接口和自举电路及其参数

注:

- $R_{\theta JCB}$ 是根据应用电路板布局得出的模拟值。(请参考用户指导手册 SPM7 系列)
- 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。
- (虚线显示部分) 每个输入端的 RC 耦合 (R_5 和 C_5)，可用于防止由浪涌噪声产生的错误输入信号。SPM® 的信号输入与标准 COMS 或 LSTTL 的输出兼容。
- 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。

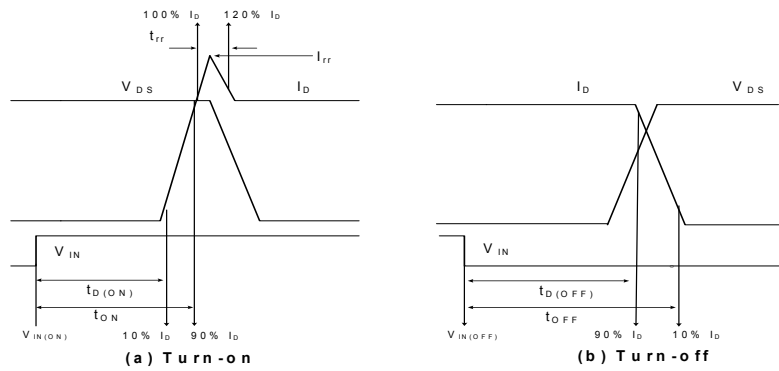


图 3. 开关时间的定义

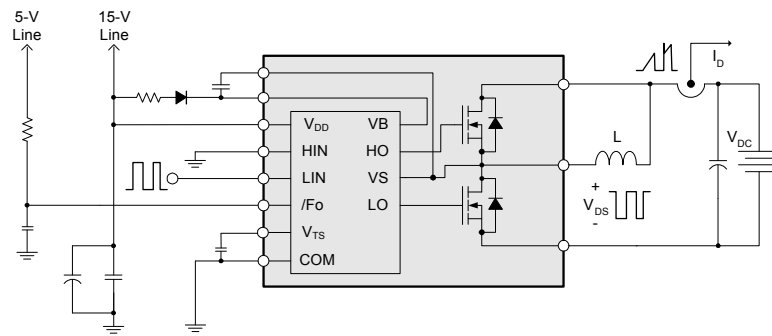


图 4. 开关测试电路（低端）

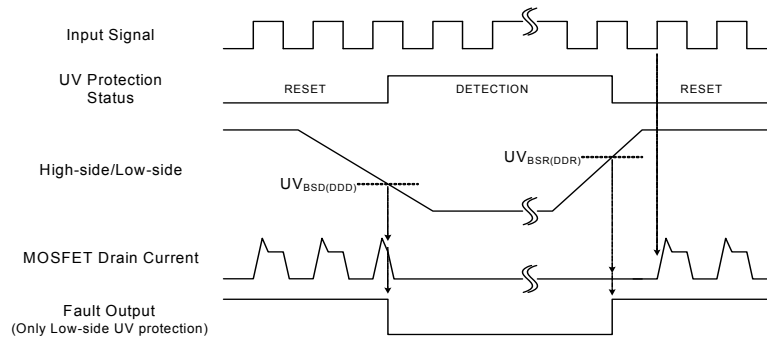


图 5. 欠压保护

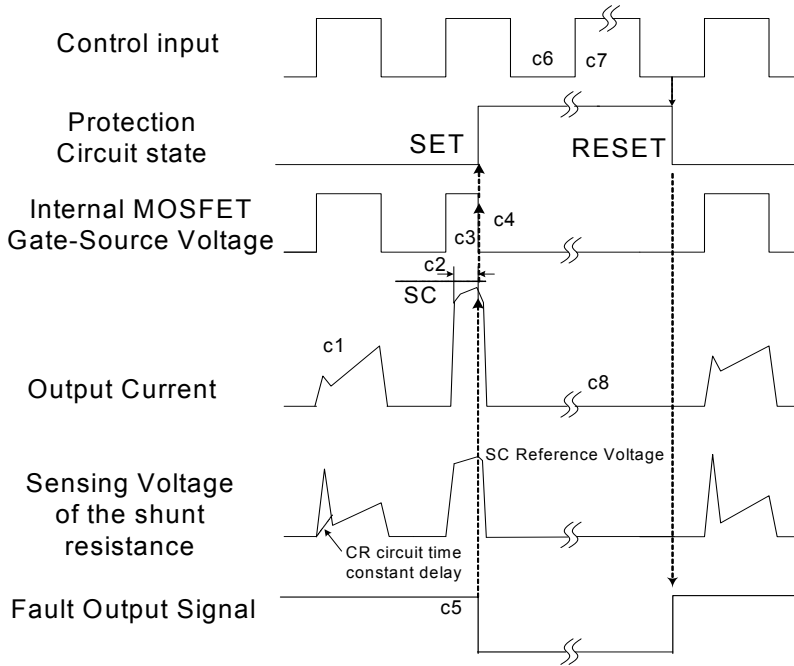


图 6. 短路电流保护

(包含外部分流电阻和 CR 连接)

- c1: 正常工作: MOSFET 导通并加载电流。
- c2: 短路电流检测 (SC 触发)。
- c3: MOSFET 栅极硬中断。
- c4: MOSFET 关断。
- c5: 故障输出延时工作启动: 故障持续时间 (t_{FOD})。
- c6: 输入 "L": MOSFET 关断状态。
- c7: 输入 "H": MOSFET 导通状态, 但是在故障输出有效的时间内, MOSFET 不导通。
- c8: MOSFET 关断状态。

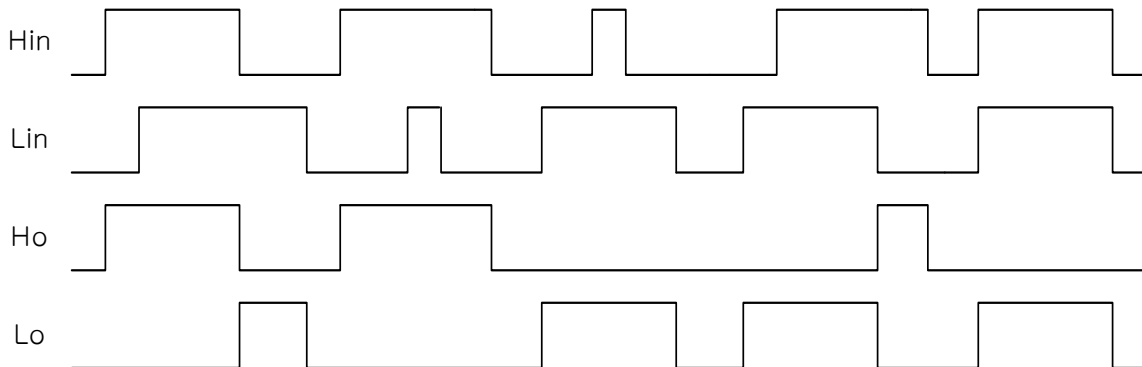


图 7. 互锁功能的时间图

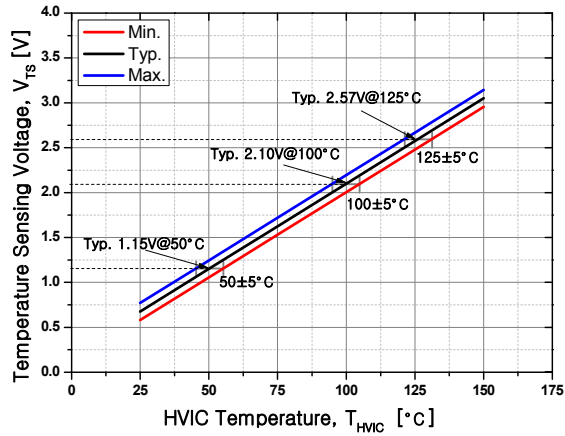


图 8. 温度曲线 V_{TS} vs. T_{HVIC}

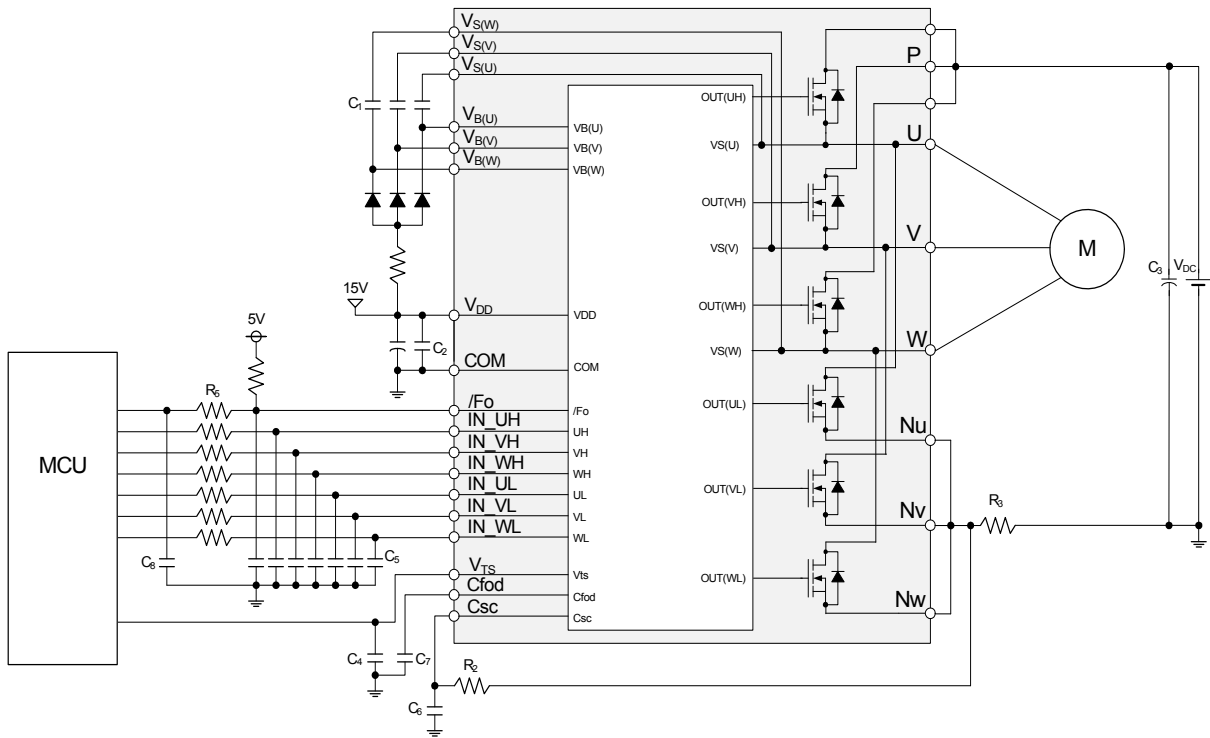
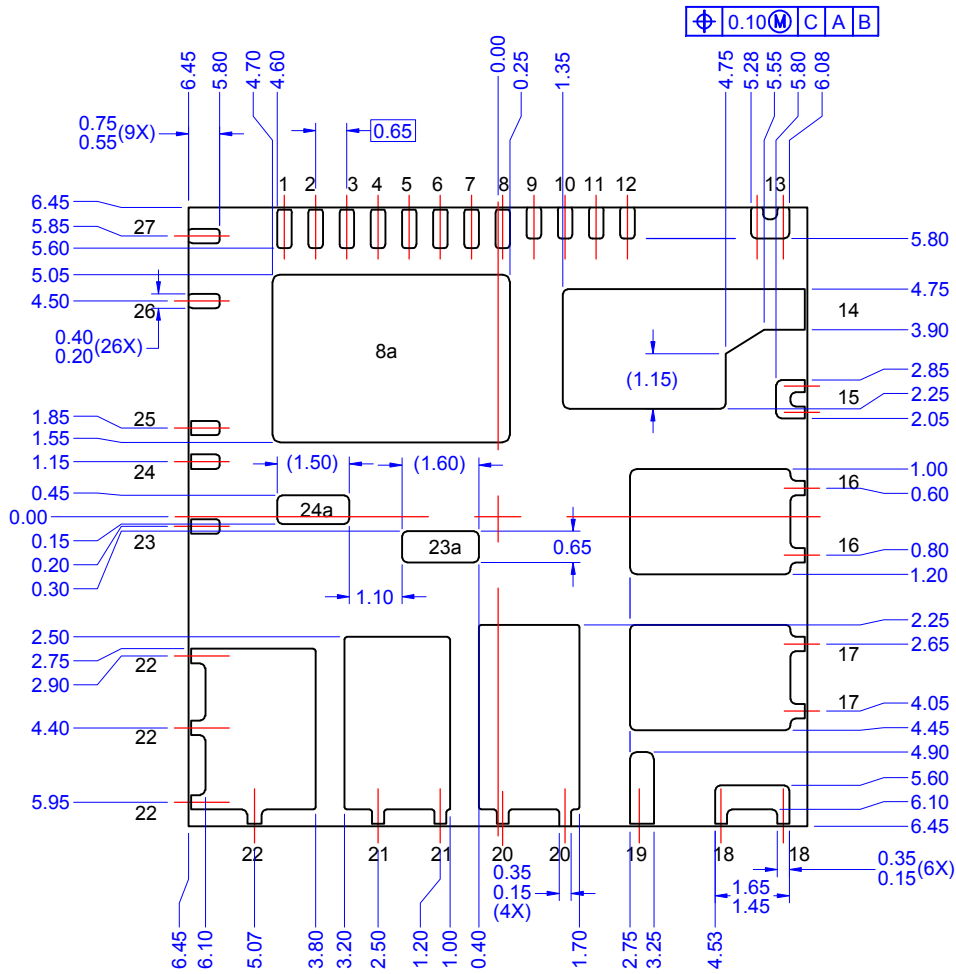


图 9. 应用电路实例

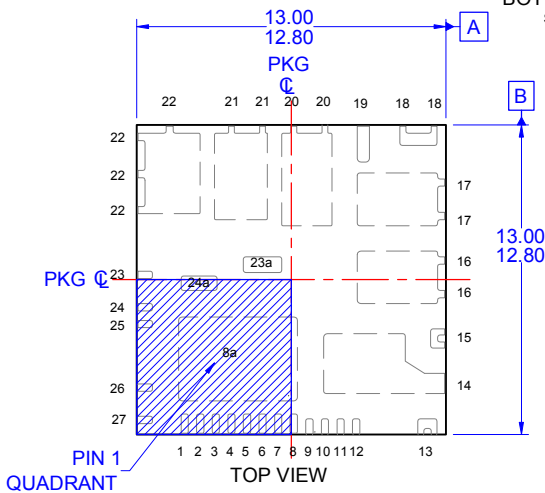
注:

1. Motion SPM® 7 产品和 MCU 的每个输入端的 RC 耦合 (R_5 和 C_5 , R_2 和 C_6) 和 C_1 , C_5 , C_7 , C_8 , 能有效的防止由浪涌噪声产生的错误的输入信号。
2. 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。
3. 所有的滤波电容器应紧密连接到 Motion SPM 7 产品, 它们应当具有能够很好的阻挡高频纹波电流的特性。

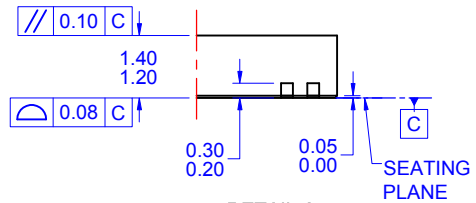


BOTTOM VIEW

SCALE: 2:1

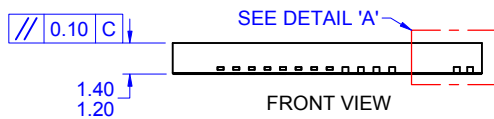


TOP VIEW

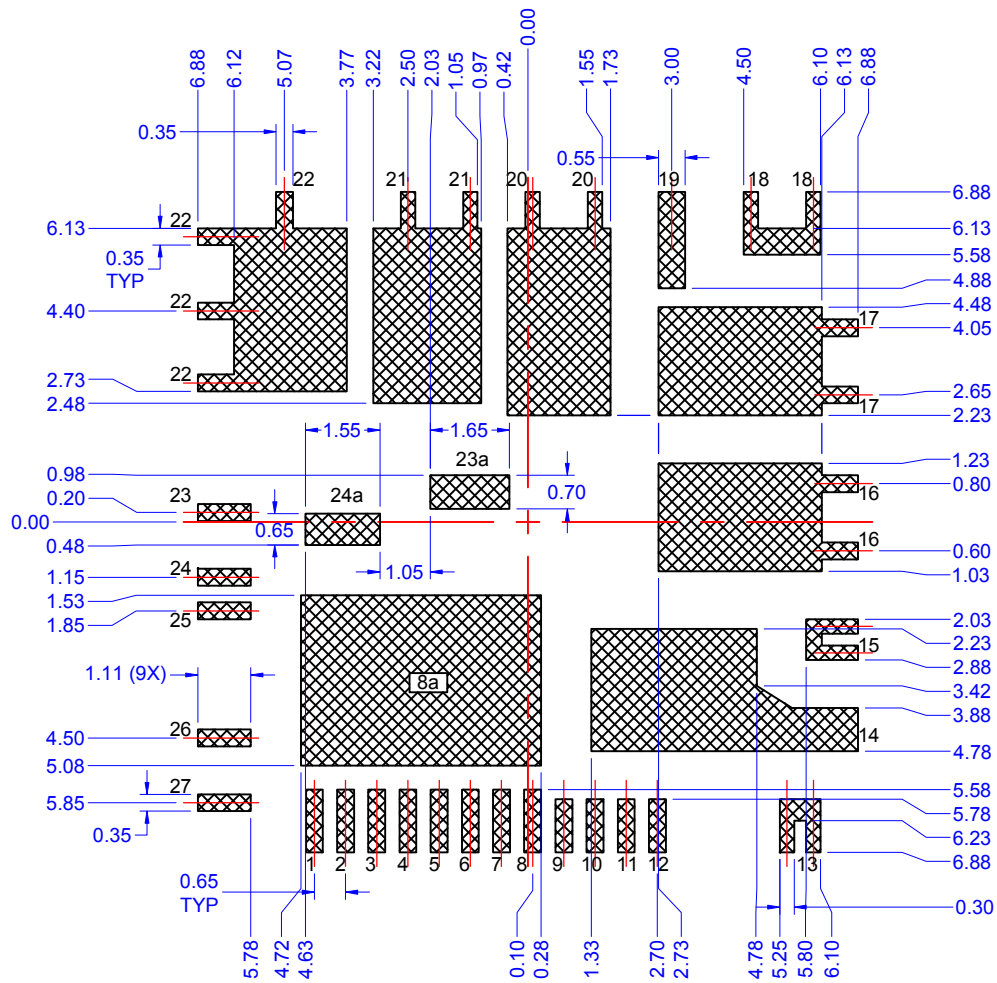


DETAIL A

SCALE: 2:1



FRONT VIEW



LAND PATTERN
RECOMMENDATION
SCALE: 2:1

NOTES: UNLESS OTHERWISE SPECIFIED

- A) THIS PACKAGE IS NOT PRESENTLY REGISTERED TO ANY STANDARD COMMITTEE.
- B) DIMENSIONS DO NOT INCLUDE BURRS OR MOLD FLASH. MOLD FLASH OR BURRS DOES NOT EXCEED 0.10MM.
- C) ALL DIMENSIONS ARE IN MILLIMETERS.
- D) DRAWING CONFORMS TO ASME Y14.5M-1994.
- E) LAND PATTERN REFERENCE:
QFN65P1290X1290X140-40N-40N
- F) DRAWING FILE NAME: MKT-PQFN27AREV3.
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