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FPAM30LH60

用于两相交错式功率因数校正的 PFC SPM[®] 2 系列

特性

- 通过 UL 第 E209204 号认证 (UL1557)
- 600 V - 30 A 两相交错式功率因数校正, 包含栅极驱动和保护的控制 IC
- 采用 DBC (Al₂O₃) 基板实现非常低的热阻
- 全波桥式整流器和高性能输出二极管
- 针对 20 kHz 开关频率进行优化
- 内置负温度系数热敏电阻可实现温度监测
- 绝缘等级: 2500 V_{rms}/分钟

应用

- 两相交错式功率因数校正转换器

相关资料

• [即将发布](#)

概述

FPAM30LH60 是 PFC SPM[®] 2 模块, 为消费、医药和工业应用提供非常全面的高性能交错式功率因数校正输入功率平台。这些模块综合优化了内置 IGBT 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, 过流保护, 热量监测和故障报告。这些模块内的全波整流器和高性能输出二极管, 为额外节省空间和方便安装起到了重要作用。

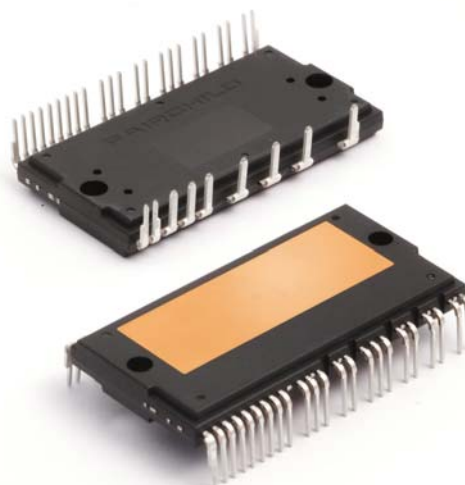


图 1. 封装概览

封装标识与订购信息

器件	器件标识	封装	包装类型	数量
FPAM30LH60	FPAM30LH60	S32EA-032	Rail	8

集成的驱动、保护和系统控制功能

- 对于 IGBT: 栅极驱动电路、过流保护 (OCP)、控制电源欠压锁定 (UVLO) 保护
- 故障信号: 对应 OC 和 UV 故障
- 内置热敏电阻: 温度监控
- 输入接口: 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

引脚布局

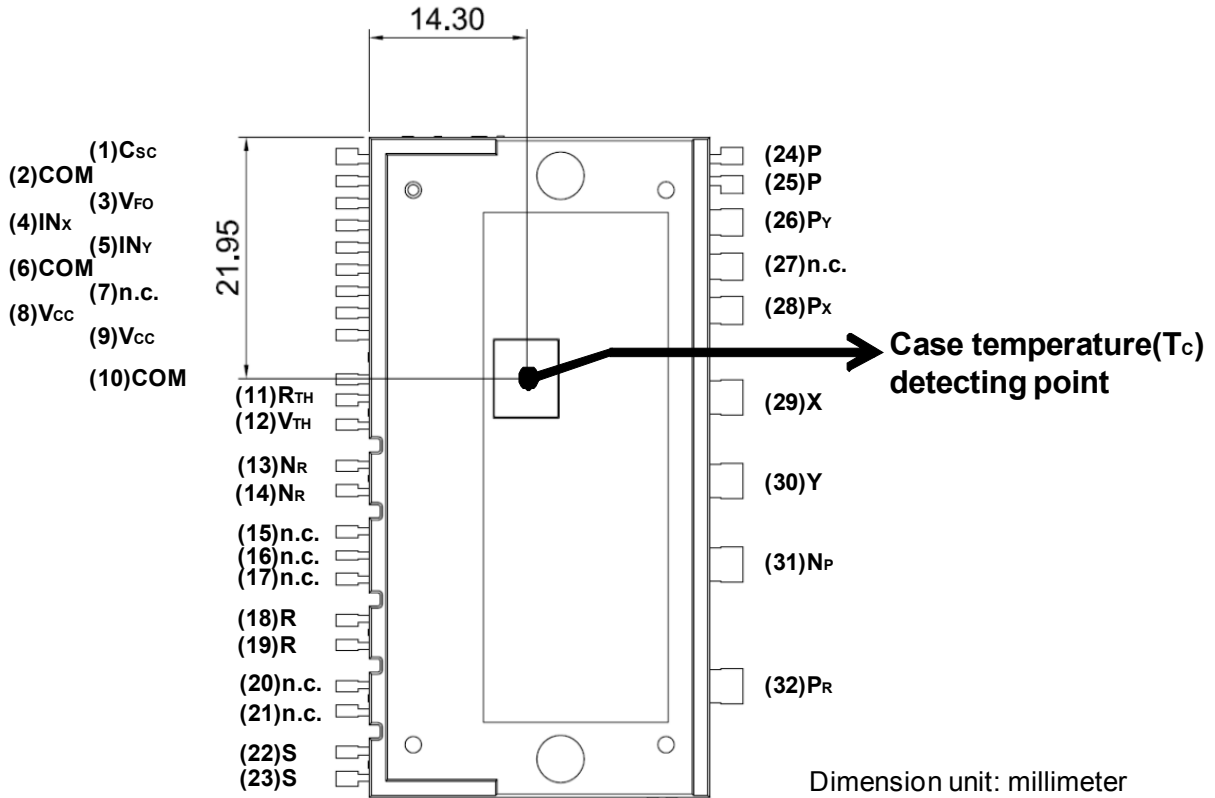


图 2. 俯视图

引脚描述

引脚号	引脚名	引脚描述
1	C _{SC}	过流检测的信号输入
2,6,10	COM	公共电源接地
3	V _{FO}	故障输出
4	IN _X	X IGBT 驱动的 PWM 输入
5	IN _Y	Y IGBT 驱动的 PWM 输入
7	N.C	无连接
8,9	V _{CC}	适用于 IGBT 驱动的 IC 的公共电源电压
11	R _{TH}	供热敏电阻使用的串联电阻器
12	V _{TH}	热敏电阻偏压
13,14	N _R	整流二极管的直流负端
15,16,17	N.C	无连接
18,19	R	R 相的交流输入
20,21	N.C	无连接
22,23	S	S 相的交流输入
24,25	P	二极管的输出
26	P _Y	二极管的输入
27	N.C	无连接
28	P _X	二极管的输入
29	X	X 相 IGBT 的输出
30	Y	Y 相 IGBT 的输出
31	N _P	IGBT 的直流负端
32	P _R	整流二极管的直流正端

内部等效电路

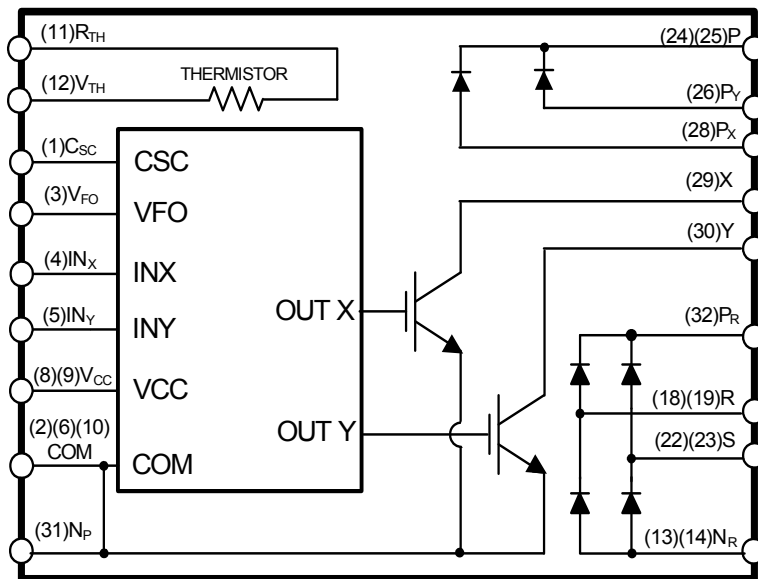


图 3. 内部框图

绝对最大额定值 ($T_J = 25^\circ\text{C}$, 除非另有说明。)**转换器部分**

符号	参数	工作条件	额定值	单位
V_i	输入电源电压	施加在 R - S 之间	264	V_{rms}
V_{PN}	输出电压	施加在 X - N _P , Y - N _P , P - P _X , P - P _Y	450	V
V_{PN} (浪涌)	输出电源电压 (浪涌)	施加在 X - N _P , Y - N _P , P - P _X , P - P _Y	500	V
V_{CES}	集电极 - 发射极之间电压	X - N _P , Y - N _P 之间的击穿电压	600	V
V_{RRM}	快速恢复二极管的重复峰值反向电压	P - P _X , P - P _Y 之间的击穿电压	600	V
V_{RRMR}	整流器的重复峰值反向电压	P _R - R, P _R - S, R - N _R , S - N _R 之间的击穿电压	900	V
* I_F	快速恢复二极管的正向电流	$T_C = 25^\circ\text{C}$, $T_J < 125^\circ\text{C}$	30	A
* I_{FSM}	快速恢复二极管的峰值浪涌电流	非重复性, 60 Hz 单一正弦半波	300	A
* I_{FR}	正向整流电流	$T_C = 25^\circ\text{C}$, $T_J < 125^\circ\text{C}$	30	A
* I_{FSMR}	整流器的峰值浪涌电流	非重复性, 60 Hz 单一正弦半波	300	A
$\pm I_{IC}$	单个 IGBT 的集电极电流	$T_C = 25^\circ\text{C}$, $T_J < 125^\circ\text{C}$	30	A
$\pm I_{ICP}$	单个 IGBT 的集电极电流 (峰值)	$T_C = 25^\circ\text{C}$, $T_J < 125^\circ\text{C}$, 脉冲宽度小于 1 ms	60	A
* P_C	集电极功耗	$T_C = 25^\circ\text{C}$ 单个 IGBT	107	W
T_J	工作结温	(注 1)	-40 ~ 125	$^\circ\text{C}$

注:

1. PFC SPM® 产品集成的功率芯片的最大额定结温是 125 $^\circ\text{C}$ 。
2. 标记为 "*" 的为计算值或设计因素。

控制部分

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} - COM 之间	20	V
V_{IN}	输入信号电压	施加在 IN _X , IN _Y - COM 之间	-0.3 ~ $V_{CC} + 0.3$	V
V_{FO}	故障输出电源电压	施加在 V_{FO} - COM 之间	-0.3 ~ $V_{CC} + 0.3$	V
I_{FO}	故障输出电流	V_{FO} 引脚处的灌电流	1	mA
V_{SC}	电流感测输入电压	施加在 C_{SC} - COM 之间	-0.3 ~ $V_{CC} + 0.3$	V

整个系统

符号	参数	工作条件	额定值	单位
T_{STG}	存储温度		-40 ~ 125	$^\circ\text{C}$
V_{ISO}	绝缘电压	60 Hz, 正弦波形, 交流 1 分钟, 连接陶瓷基板到引脚	2500	V_{rms}

热阻

符号	参数	条件	最小值	典型值	最大值	单位
$R_{th(j-c)Q}$	结点 - 壳体的热阻	工作条件下的单个 IGBT	-	-	0.93	$^\circ\text{C/W}$
$R_{th(j-c)D}$		工作条件下的单个二极管	-	-	1.42	$^\circ\text{C/W}$
$R_{th(j-c)R}$		工作条件下的单个整流器	-	-	0.74	$^\circ\text{C/W}$

电气特性 (T_J = 25°C, 除非另有说明。)

转换器部分

符号	参数	工作条件	最小值	典型值	最大值	单位
V _{CE(SAT)}	IGBT 饱和电压	V _{CC} = 15 V, V _{IN} = 5 V, I _C = 30 A	-	1.7	2.2	V
V _{FF}	快速恢复二极管正向电压	I _F = 30 A	-	1.9	2.4	V
V _{FR}	整流器正向电压	I _{FR} = 30 A	-	1.10	1.25	V
I _{RR}	开关特性	V _{PN} = 400 V, V _{CC} = 15 V, I _C = 15 A, V _{IN} = 0 V ↔ 5 V, 感性负载 (注 3), 单个 IGBT	-	11	-	A
t _{RR}			-	41	-	ns
t _{ON}			-	700	-	ns
t _{OFF}			-	852	-	ns
t _{C(ON)}			-	104	-	ns
t _{C(OFF)}			-	102	-	ns
I _{CES}	集电极 - 发射极间漏电流	V _{CES} = 600 V	-	-	250	μA

注:

3. t_{ON} 和 t_{OFF} 包括模块内部驱动 IC 的传输延迟时间。t_{C(ON)} 和 t_{C(OFF)} 指在内部给定的栅极驱动条件下, IGBT 本身的开关时间。详细信息, 请参见图 4。

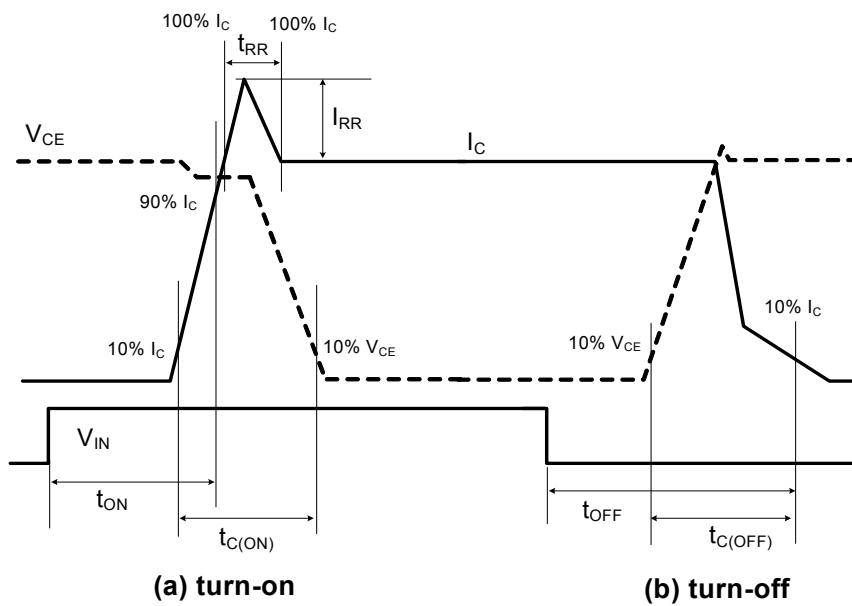


图 4. 开关时间的定义

控制部分

符号	参数	工作条件	最小值	典型值	最大值	单位
I_{OCC}	V_{CC} 静态电源电流	$V_{CC} = 15\text{ V}$, IN_X , $IN_Y - COM = 0\text{ V}$, V_{CC} 和 COM 间的电源电流	-	-	2.65	mA
I_{PCC}	工作 V_{CC} 电源电流	$V_{CC} = 15\text{ V}$, $f_{PWM} = 20\text{ kHz}$, $Duty = 50\%$ 应用于单个 IGBT 的一个 PWM 信号输入 V_{CC} 和 COM 间的电源电流	-	-	6.0	mA
V_{FOH}	故障输出电压	$V_{SC} = 0\text{ V}$, V_{FO} 电路: $10\text{ k}\Omega$ 至 5 V 上拉	4.5	-	-	V
V_{FOL}		$V_{SC} = 1\text{ V}$, V_{FO} 电路: $10\text{ k}\Omega$ 至 5 V 上拉	-	-	0.5	V
$V_{SC(Ref)}$	CSC 引脚的过流保护触发电平电压	$V_{CC} = 15\text{ V}$	0.45	0.50	0.55	V
UV_{CCD}	电源电路欠压保护	检测电平	10.5	-	13.0	V
UV_{CCR}		复位电平	11.0	-	13.5	V
t_{FOD}	故障输出脉宽		30	-	-	μs
$V_{IN(ON)}$	导通阈值电压	施加在 IN_X , $IN_Y - COM$ 之间	2.6	-	-	V
$V_{IN(OFF)}$	关断阈值电压	施加在 IN_X , $IN_Y - COM$ 之间	-	-	0.8	V
R_{TH}	热敏电阻的阻值	当 $T_{TH} = 25^\circ\text{C}$ (注 4, 图 5)	-	47	-	$\text{k}\Omega$
		当 $T_{TH} = 100^\circ\text{C}$ (注 4, 图 5)	-	2.9	-	$\text{k}\Omega$

注:

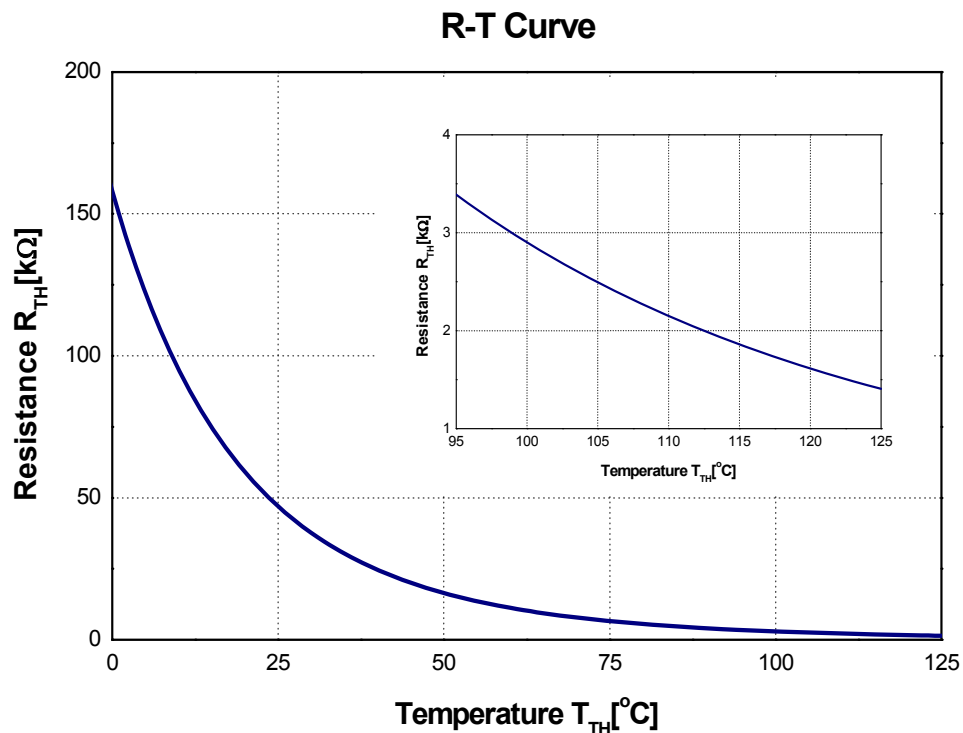
4. T_{TH} 为热敏电阻自身的温度。若需得到壳体温度 (T_C), 请根据具体应用进行实验。

图 5. 内置热敏电阻的 R-T 曲线

推荐工作条件 ($T_J = 25^\circ\text{C}$, 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_i	输入电源电压	施加在 R - S 之间	187	-	253	V_{rms}
I_i	输入电流	$T_C < 100^\circ\text{C}$, $V_i = 220\text{ V}$, $V_O = 360\text{ V}$, $f_{PWM} = 20\text{ kHz}$ 单个 IGBT	-	-	21	A_{rms}
V_{PN}	电源电压	施加在 X - N _P , Y - N _P , P - P _X , P - P _Y	-	-	400	V
V_{CC}	控制电源电压	施加在 V_{CC} - COM 之间	13.5	15.0	16.5	V
dV_{CC}/dt	电源波动		-1	-	1	$V/\mu\text{s}$
I_{FO}	故障输出电流	V_{FO} 引脚处的灌电流	-	-	1	mA
f_{PWM}	PWM 输入频率	$-40^\circ\text{C} < T_J < 125^\circ\text{C}$ 单个 IGBT	-	20	-	kHz

机械特性和额定值

参数	工作条件		最小值	典型值	最大值	单位
安装扭矩	安装螺钉: M4	建议 0.98 N•m	0.78	0.98	1.17	N•m
		建议 10 kg•cm	8	10	12	kg•cm
器件平面度	见图 6		0	-	+150	μm
重量			-	32	-	g

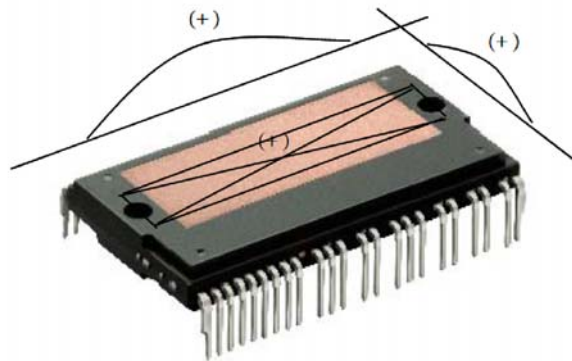
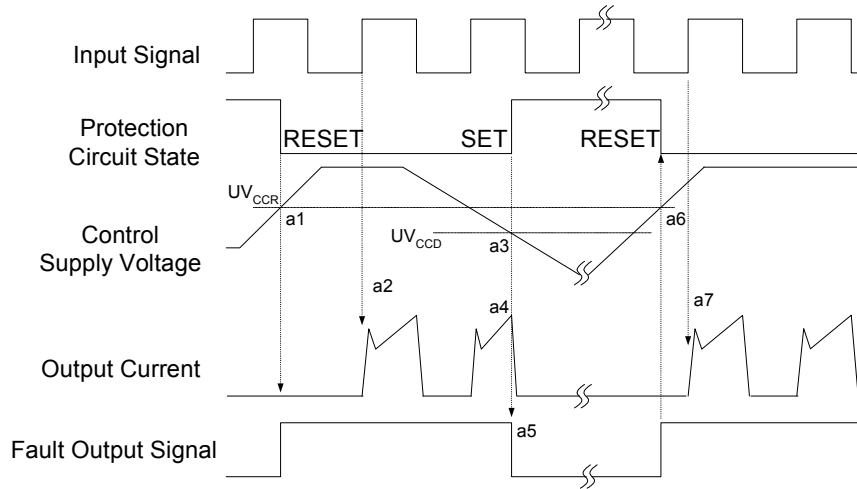


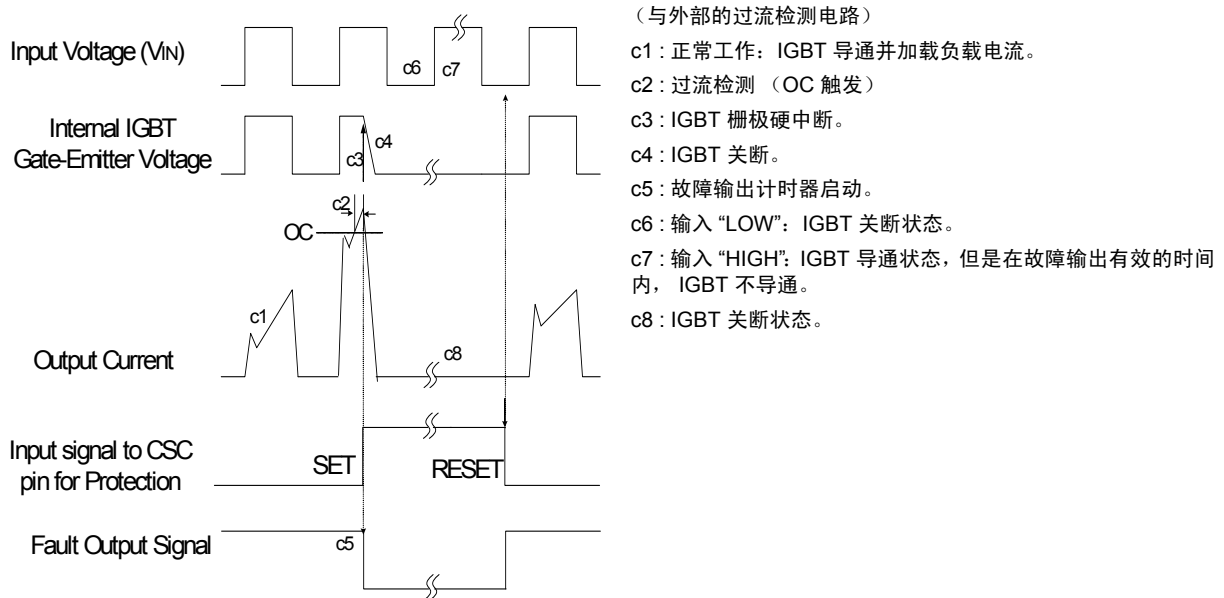
图 6. 平面度测量位置

保护功能时序图



- a1: 控制电源电压上升: 当电压上升到 UV_{CCR} 后, 等到下一个开通信号时, 对应的电路才开始动作。
- a2: 正常工作: IGBT 导通并加载负载电流。
- a3: 欠压检测 (UV_{CCD})。
- a4: 不论控制输入的条件, IGBT 都关断。
- a5: 故障输出工作启动。
- a6: 欠压复位 (UV_{CCR})。
- a7: 正常工作: IGBT 导通并加载负载电流。

图 7. 欠压保护



(与外部的过流检测电路)

- c1: 正常工作: IGBT 导通并加载负载电流。
- c2: 过流检测 (OC 触发)
- c3: IGBT 栅极硬中断。
- c4: IGBT 关断。
- c5: 故障输出计时器启动。
- c6: 输入 "LOW": IGBT 关断状态。
- c7: 输入 "HIGH": IGBT 导通状态, 但是在故障输出有效的时间内, IGBT 不导通。
- c8: IGBT 关断状态。

图 8. 过流保护

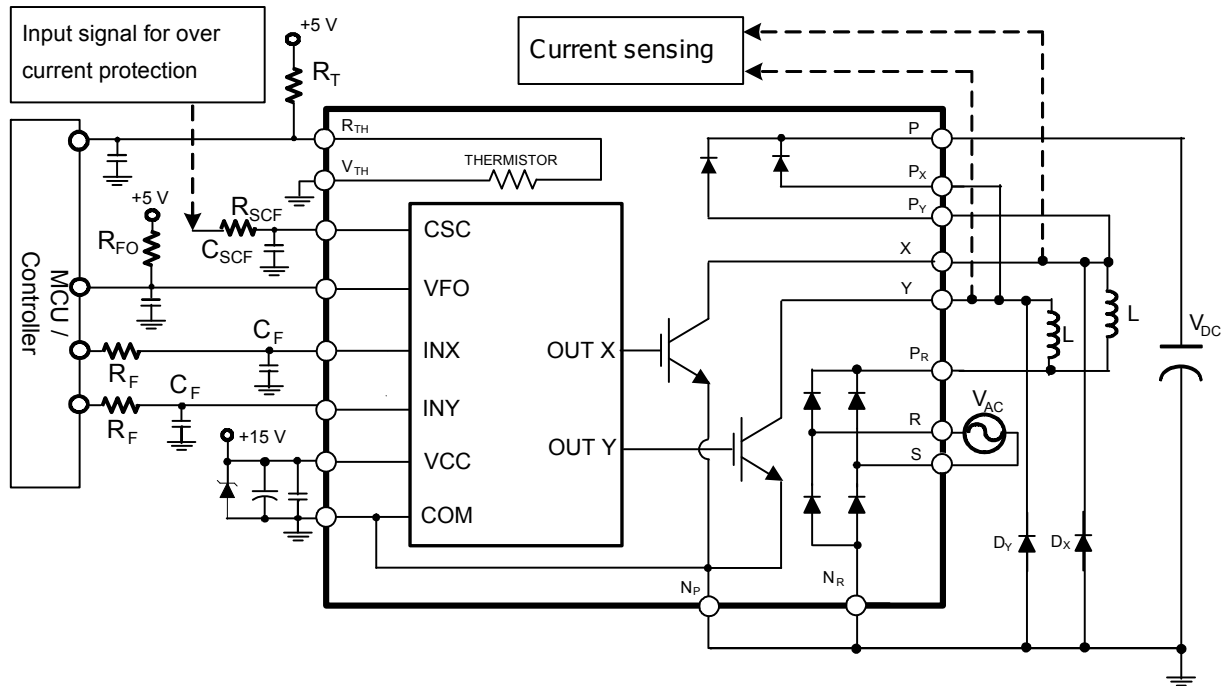
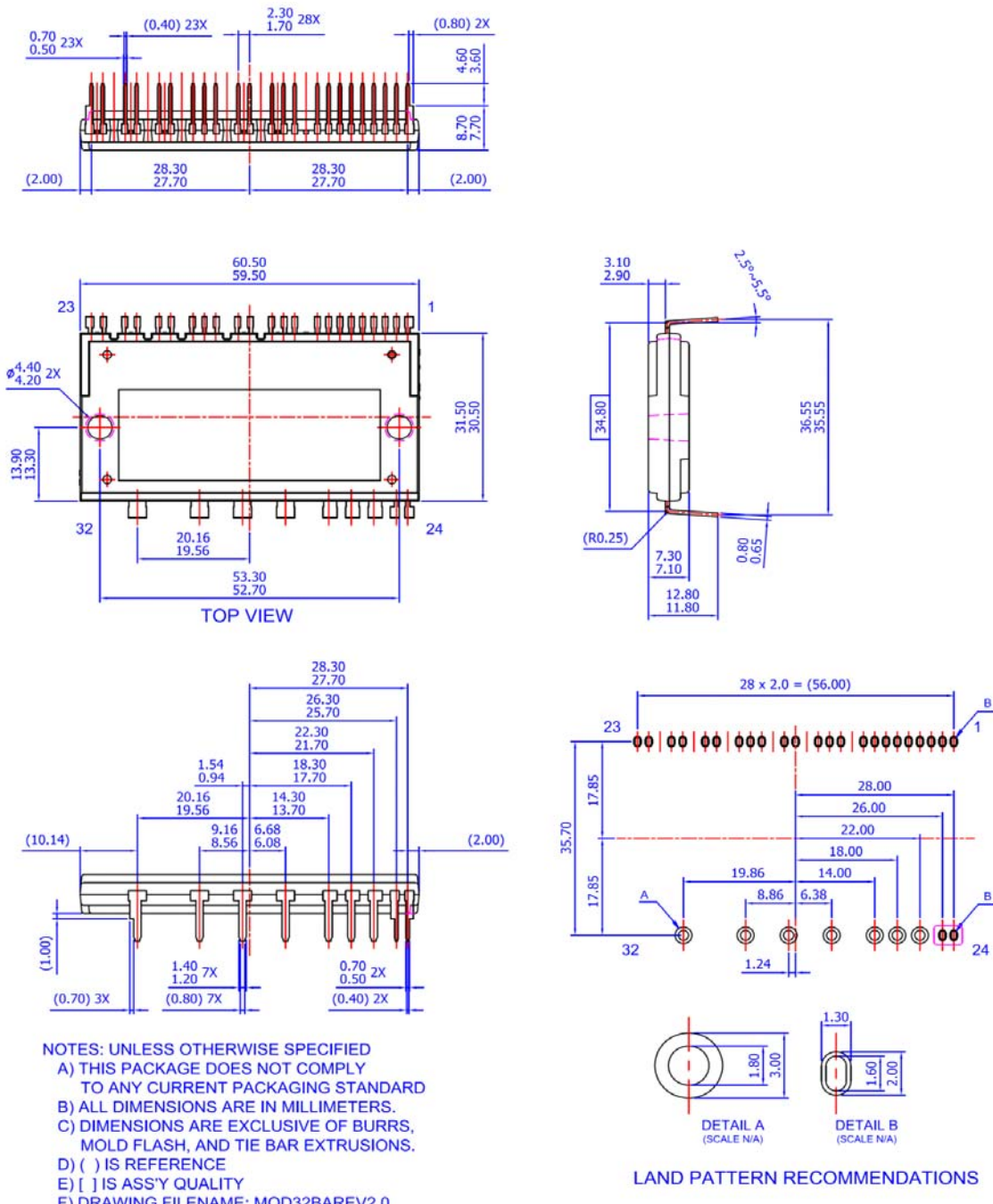


图 9. 典型应用电路

注:

1. 为了避免故障，每个输入端的连线必须尽可能的短（小于 2 ~ 3 cm）。
2. V_{F0} 输出是漏极开路型。该信号线应当采用一个能把 I_{F0} 上升到 1 mA 的电阻上拉至 MCU 或控制电源的正极。
3. 输入信号为高电平有效。在 IC 中，有一个 5 kΩ 的电阻将每一个输入信号线下拉接地。应采用 RC 耦合电路，以避免输入信号波动。R_FC_F 常数应当在 50~150ns 范围内选择（推荐 R_F = 100 Ω，C_F = 1 nF）。
4. 为避免保护功能出错，应尽可能缩短 R_{SCF} 和 C_{SCF} 周围的连线。
5. 在短路保护电路中，R_{SCF}、C_{SCF} 时间常数应在 1.5 ~ 2 μs 范围内进行选择。
6. 每个电容都应尽可能地靠近 PFC SPM[®] 产品的引脚安装。
7. 在各种家用电器设备中，几乎都用到了继电器。在这些情况下，MCU / 控制器和继电器之间应留有足够的距离。
8. 内部负温度系数热敏电阻用来监控壳体温度，以及保护器件免于过热工作。根据应用选择一个适当的电阻 R_T。
9. 建议将反向并联二极管 (D_X, D_Y) 与每个 IGBT 相连接。

封装轮廓详图



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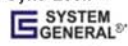



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