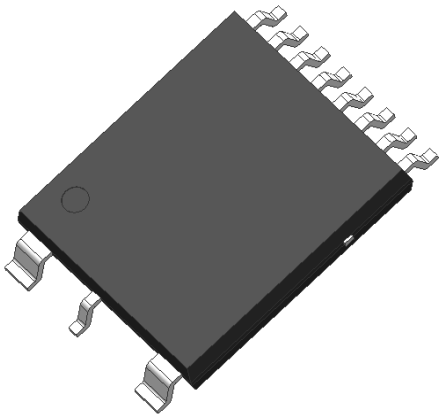
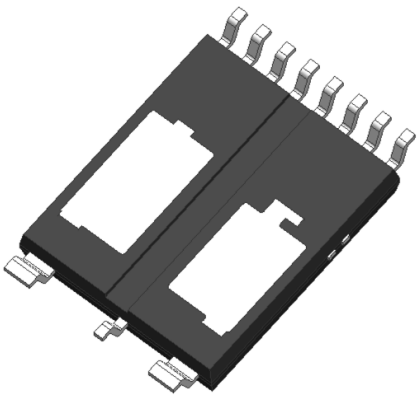
SPE03M60B-CH

主要参数 MAIN CHARACTERISTICS

600V/2A 半桥驱动	
V_{DSS}	600V
I_D	2A
I_{DM}	4A

封装 Package





SOP12B

用途 APPLICATIONS

- 空调室内风机 • Air conditioner fan
- 风扇 • Electric fan
- 高速吹风机 • High speed hair dryer
- 水泵 • Pump

产品特性 FEATURES

- 信号高电平有效，兼容 3.3V 和 5V 的 MCU • Signal high level valid, compatible with 3.3v and 5V MCU
- 下臂 MOSFET 源极输出 • Lower arm MOSFET source electrode output
- 内置自举二极管 • Built-in bootstrap diode
- 内置防直通保护 • Built-in straight through protection
- 内置欠压保护 • Built-in undervoltage protection
- 内置过流保护 • Built-in overcurrent protection
- 使能关断功能 • Shut−Down Input
- 内部集成温度检测输出 • Internal integrated temperature detection output

订货信息 ORDER MESSAGE

订 货 料 号 Order number	产 品 信 息 Product information			
	无卤-条管 Halogen-Free-Tube	无卤-编带 Halogen-Free-Reel	印 记 Marking	封 装 Package
2A01-0837	SPE03M60B-CH	N/A	03M60B-CH	SOP12B

模块分布示意图 Module distribution diagram

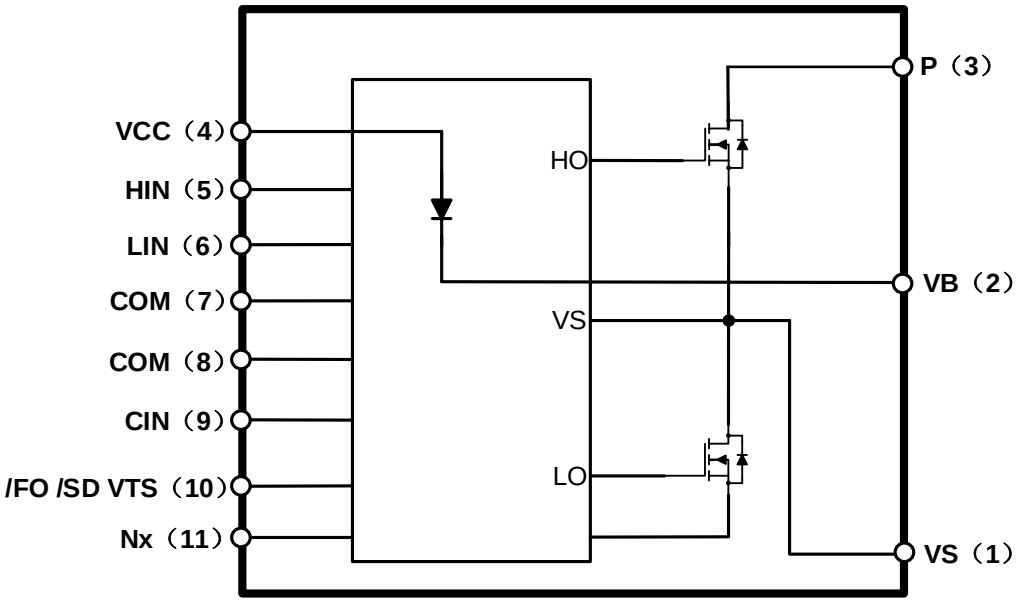


图 1：模块内部电路示意图

Fig 1: Internal circuit

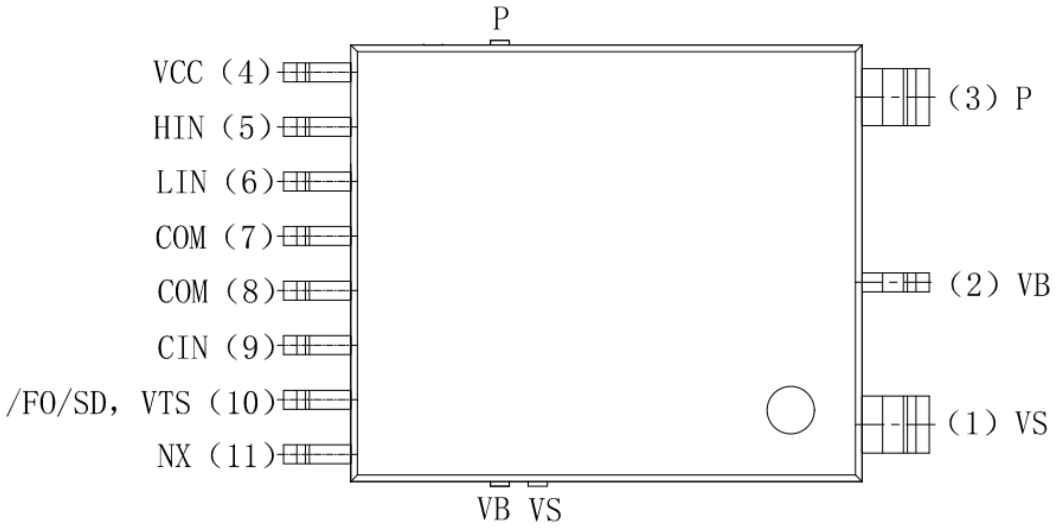


图 2.1：模块正面引脚分布示意图

Fig 2.1: Distribution of pin

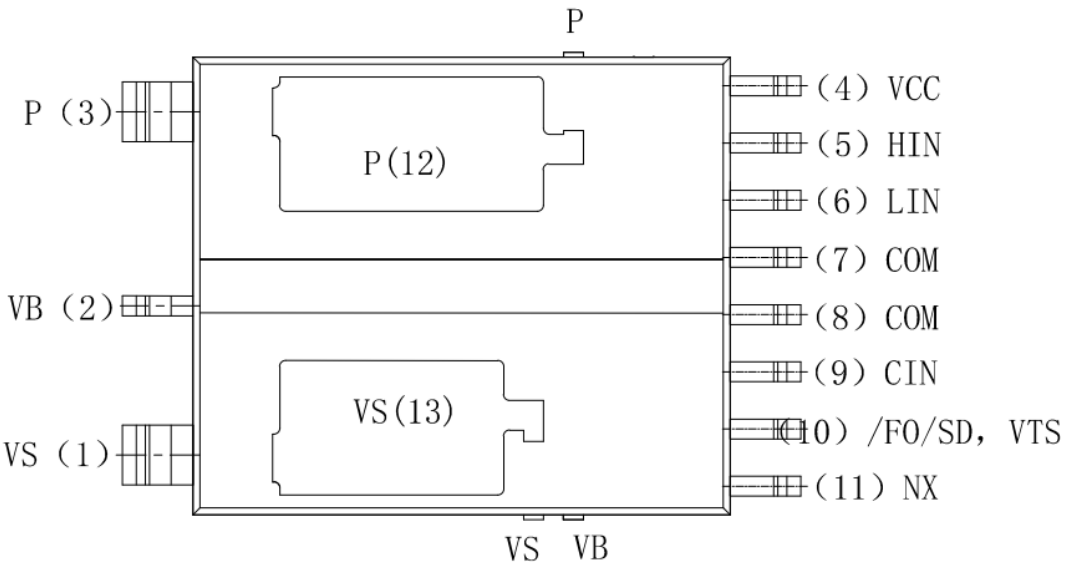


图 2.2：模块背面引脚分布示意图

Fig 2.2: Distribution of pin

引脚编号 Number	引脚名称 Name	引脚描述 Description
1	VS	控制电源 GND 端子 IC Common Supply Ground
2	VB	U 相上臂驱动电源端子 Bias Voltage for U-Phase High-Side MOSFET Driving
3	P	逆变器直流输入端子 Positive DC-Link Input
4	VCC	控制电源端子 Bias Voltage for V-Phase IC and Low Side MOSFET Driving
5	HIN	上臂控制信号输入端子 Signal Input for U-Phase High-Side
6	LIN	下臂控制信号输入端子 Signal Input for U-Phase Low-Side
7	COM	控制电源 GND 端子 IC Common Supply Ground
8	COM	控制电源 GND 端子 IC Common Supply Ground
9	CIN	短路保护触发电压检测端子 Short circuit protection trigger voltage detection
10	FO/SD/VTS	故障输出/输入关闭/温度输出端子 Fault output/input shutdown/temperature output
11	Nx	下臂 MOSFET 源极端子 Negative DC-Link
12	P	逆变器直流输入端子 Positive DC-Link Input
13	VS	控制电源 GND 端子 IC Common Supply Ground

图 3：模块引脚功能定义表

Fig 3: Pin function

最大额定值 (T_j= 25℃,除非特殊说明）

Absolute Maximum Ratings （T_j= 25℃, Unless otherwise Specified）

逆变部分 Inverter Part

记号 Symbo	参数 Parameter	条件 Condition	额定值 Ratings	单位 Units
V_{DSS}	漏极－源极直流电压 Drain-Source Voltage		600	V
I_D	连续漏极电流 Drain Current-continuous	Tc = 25℃	2	A
I_{DM}	漏极电流（峰值）	Tc = 25℃, 脉冲宽度小于 100us	4	A
P_C	最大耗散功耗 Maximum Power Dissipation	TC = 25℃， 单晶片 TC = 25℃，Each MOS	19	W
Tj	结温 Operating Junction Temperature	/	-40~150	℃

控制部分 Control Part

记号 Symbol	参数 Parameter	条件 Condition	额定值 Ratings	单位 Units
V_{CC}	控制电源电压 Control Supply Voltage	V_{CC}-COM 之间 Applied between VCC and COM	20	V
V_{BS}	高侧控制电压 High-side Bias Voltage	V_B-V_S 之间 Applied between VB and VS	20	V
V_{IN}	输入信号电压 Input Signal Voltage	V_{IN}-COM 之间 Applied between VIN and COM	-0.3~V_{CC}+0.3	V
V_{FO}	故障输出电压 Function Supply Voltage	V_{FO} -COM 之间 Applied between VFO and COM	-0.3~V_{CC}+0.3	V
V_{SC}	过流触发电压 Current Sensing Input Voltage	V_{SC} -COM 之间 Applied between VSC and COM	-0.3~V_{CC}+0.3	V

内部自举电路 Bootstrap Diode Part

记号 Symbol	参数 Parameter	条件 Condition	额定值 Ratings	单位 Units
V_{RRMB}	反向耐压 Control Supply Voltage	/	600	V

整个系统 Total System

记号 Symbol	参数 Parameter	条件 Condition	额定值 Ratings	单位 Units
V_{PN}	电源电压 Power supply voltage	V_{CC}=V_{BS}=13.5V~16.5V, TJ=125°C, 非重复性, <2us	450	
T_j	结温 Operating Junction Temperature	/	-40~150	℃
T_C	模块壳体工作温度 Module shell temperature	-	-20~100	℃
T_{STG}	贮存温度 Storage Temperature	TC=25℃	-40~125	℃
V_{ISO}	绝缘耐压 Isolation Voltage	60Hz，正弦，AC 1 分钟，连接管脚到散热器 60Hz, Sinusoidal,AC 1 min,between pins and heat-sink plate	1500	Vrms

备注 1：IPM 功率晶片最大额定结温为 150°C(@表面温度 TC≤ 100°C)。然而,为了确保 IPM 运行安全，结温应限定于 Tj(av) ≤ 125°C (@表面温度 Tc ≤ 100°C)。

Note 1： The maximum rated junction temperature of the IPM power chip is 150°C (@surface temperature TC≤ 100°C

热阻 Thermal Resistance

记号	参数	条件	典型值	单位
Rth(j-c)	结到外壳的热阻	每个MOSFET	6.5	°C/W

电气特性 (Tj=25°C, 除非特殊说明)
Electrical Characteristics (TJ=25°C, Unless Otherwise Specified)

逆变部分 Inverter Part

记号	参数	条件	最小值	典型值	最大值	单位
BV_{DSS}	漏-源击穿电压	V_{IN} = 0 V, I_D = 1 mA （备注2）	600	-	-	V
I_{DSS}	零栅极电压漏极电流	V_{IN} = 0 V, V_{DS} = 600 V	-	-	10	uA
V_{SD}	源-漏二极管正向电压	V_{CC} = V_{BS} = 15V, V_{IN} = 0 V, I_D =-1 A	-	0.87	-	V
RDS(on)	漏-源导通电阻	V_{CC} = V_{BS} = 15 V, V_{IN} = 5 V, I_D = 1 A	-	2.9	3.5	ohm
Ton	开关时间	V_{PN} =400 V, V_{CC} = V_{BS} = 15 V, I_D =2A V_{IN} = 0/5 V，感性负载（备注3）	-	460	-	nS
Toff				490		nS
Trr				90		nS
Eon			-	110	-	uJ
Eoff				17		uJ

备注 2：BV_{DSS} 是单个 MOSFET 漏源最大电压。V_{PN} 应小于该值，考虑到杂散电感，V_{DS} 在任何情况下都不应超过 BV_{DSS} 。

NOTE 2：BV_{DSS} is the absolute maximum voltage rating between drain and source terminal of each FRFET inside SPM®. V_{PN} should be sufficiently less than this value considering the effect of the stray inductance so that V_{DS} should not exceed BV_{DSS} in any case.

备注 3: t_{ON} 和 t_{OFF} 包含驱动 IC 传输延迟。列表值是在实验条件下测得，不同的 PCB 及连线会改变数值。请参考图 4 的开关时间定义。

NOTE 3: t_{ON} and t_{OFF} include the propagation delay time of the internal drive IC. Listed values are measured at the laboratory test condition, and they can be different according to the field applcations due to the effect of different printed circuit boards and wirings. Please see Fig 4 for the switching time definition.

控制部分 Control Part

记号 Symbol	参数 Parameter	条件 Condition		最小值 Min.	典型值 Typ.	最大值 Max.	单位 Unit
I_{QCC}	V_{CC} 静态电流 Quiescent V_{CC} Supply Current	V_{CC}=15V V_{IN}=5V	V_{CC}-COM 之间 Applied between V_{CC} and COM	-	-	1	mA
I_{QB}	V_{BS} 静态电流 Quiescent V_{BS} Supply Current	V_{DB}=15V V_{IN}=0V	VB(U)-U，VB(V)-V，VB(W)-W 之间 Applied between VB(U)-U，VB(V)-V，VB(W)-W	-	-	500	uA
UVCCD	低侧欠压保护	检测电平		7.2	8.2	9.2	V

	Low-Side Under-Voltage Protection	VCC Under-Voltage Protection Detection Level				
UVCCR		复位电平 VCC Under-Voltage Protection Reset Level	8.2	9.2	10.2	V
UVBSD	高侧欠压保护 High-Side Under-Voltage Protection	检测电平 VBS Under-Voltage Protection Detection Level	7.0	8.0	9.0	V
UVBSR		复位电平 VBS Under-Voltage Protection Reset Level	7.5	8.5	9.5	V
t_{FOD}	故障输出脉冲宽度 Fault-Out Pulse Width	-	20	-	-	us
VIH	输入开启阈值电压 ON Threshold Voltage	逻辑高电平，加在 VIN 与 COM 之间 Logic HIGH Level, Applied between VIN and COM	-	2.6	3.0	V
VIL	输入关闭阈值电压 OFF Threshold Voltage	逻辑低电平，加在 VIN 与 COM 之间 Logic Low Level, Applied between VIN and COM	0.8	1.6	1.9	V
IFO_T	HVIC 温度检测输出电流 HVIC Temperature Sensing Current Output	VDD=VBS=15V,T=25℃	-	82.5	-	uA
		VDD=VBS=15V,T=75℃	-	207.5	-	
VFO_T	温度输出，备注 4 Temperature output, remark 4	温度 25℃，通过 10KΩ 电阻下拉至 5V Tc=25℃，10K to 5V Pull-up	-	4.18	-	V
		温度 25℃，通过 10KΩ 电阻下拉至 5V Tc=75℃，10K to 5V Pull-up	-	2.93	-	
V_{FSDR}	使能关断复位电平 Shut-down Reset level	SDx-COM	1.7	2.2	2.6	V
V_{FSDD}	使能关断阈值电压 Shut-down Detection level	SDx-COM	0.8	1.5	2.0	V
I_{IN}	输入偏执电流 Input bias current	V_{IN}=5V	0.7	0.9	1.1	mA
$V_{SC(ref)}$	短路跳闸阈值 Short-Circuit Trip Level	-	0.38	0.44	0.50	V

备注 4：如果管脚/FO，/SDW,/VTS 和其它 SDX 连接在一起时，短路（过流）保护对 6 个 MOSFET 都有效。

Note 4: If pins /FO,/SDW,/VTS, and other SDX are connected together, short-circuit (overcurrent) protection is effective for all six MOSFETs.

自举二极管部分 Bootstrap Diode Part

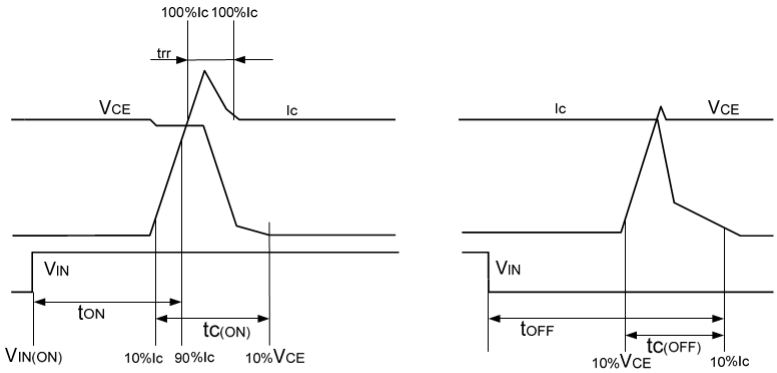
记号 Symbol	参数 Parameter	条件 Condition	最小值 Min.	典型值 Typ.	最大值 Max.	单位 Unit
R_{BS}	自举二极管阻值 Bootstrap Diode Resistance	集成在 HVIC 内 （备注 5） Integrated Within HVIC （Note 5）	-	100	-	Ω

备注 5：IPM 内部自举二极管集成在 HVIC 上，采用复合器件代替外置的快恢复二极管，恢复特性优于 FRD。

Note 5：The IPM internal bootstrap diode is integrated on the HVIC, using composite devices instead of external fast recovery diodes for better recovery characteristics.

推荐工作条件 Recommended Operating Conditions

记号 Symbol	参数 Parameter	记号 Symbol	最小值 Min.	典型值 Typ.	最大值 Max.	单位 Unit
VPN	电源电压 Supply Voltage	P-N 之间 Applied between P and N	-	300	400	V
VCC	控制电源电压 Control Supply Voltage	VCC-COM 之间 Applied between VCC and COM	13.5	15.0	16.5	V
VBS	高侧控制电源电压 High-Side Bias Voltage	VB-VS 之间 Applied between VB and VS	13.5	15.0	18.5	V
VIN(ON)	输入开启阈值电压 Input ON Threshold Voltage	VIN-COM 之间 Applied between VIN and COM	3.0	-	VCC	V
VIN(OFF)	输入关闭阈值电压 Input OFF Threshold Voltage		0	-	0.6	V
tdead	死区时间 Blanking Time for Preventing Arm-Shor	VCC=VBS=13.5~16.5V, Tj＜150℃	1.0	-	-	us
PWM	最小输入信号脉冲宽度 Minimum input signal pulse width	ON	0.7	-	-	us
		OFF	0.7	-	-	us
FPWM	PWM 开关频率 PWM Switching Frequency	Tj＜150℃	-	-	20	KHz



(a) 开启　　(b) 关断

图 4：开关时间定义

Fig 4: Switching Time Definition

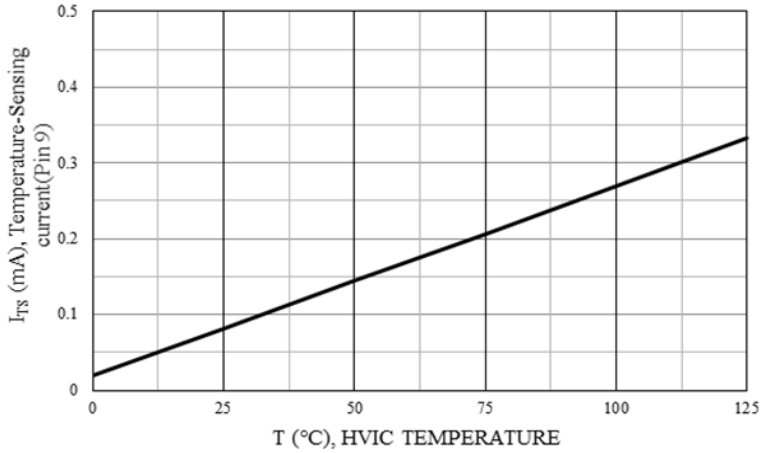


图 5.1：IC 温度输出的电流-温度曲线

Fig 5.2:I-T curve of temperature output of IFO

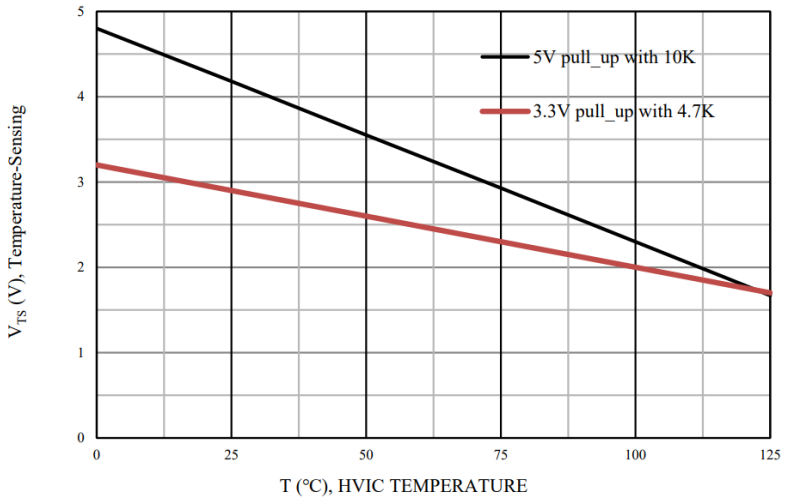


图 5.2：HVIC 温度检测输出温度—电压曲线

Fig 5.2：Curves of HVIC Temperature detection-voltage curve

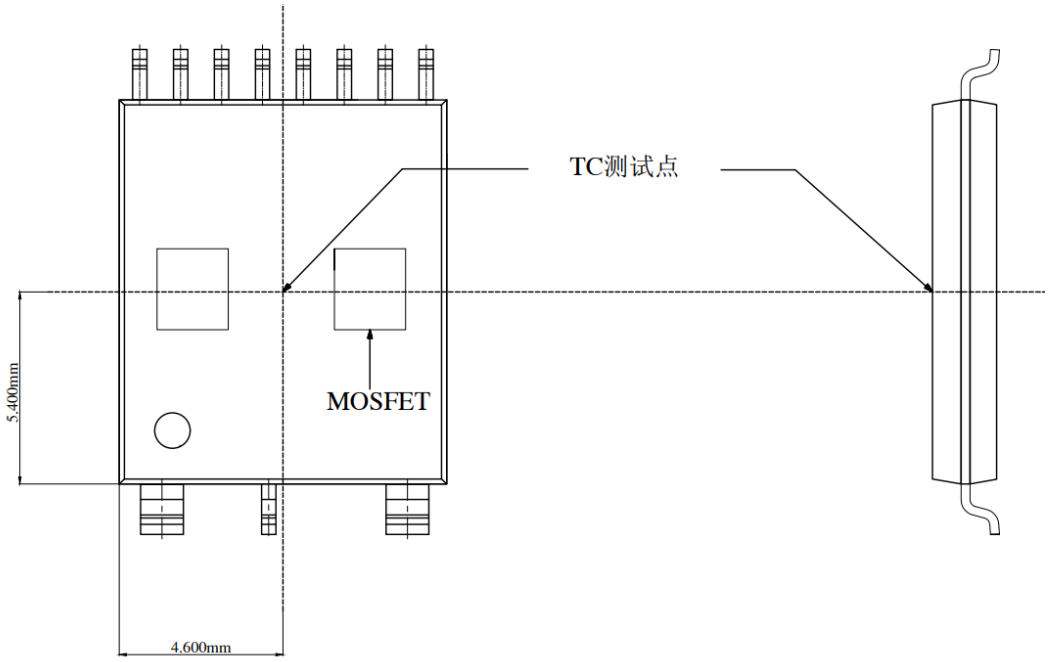


图 6：壳温 Tc 测试点

Fig 6：Case Temperature Measurement

保护功能时序图 Time Charts of Protective Function

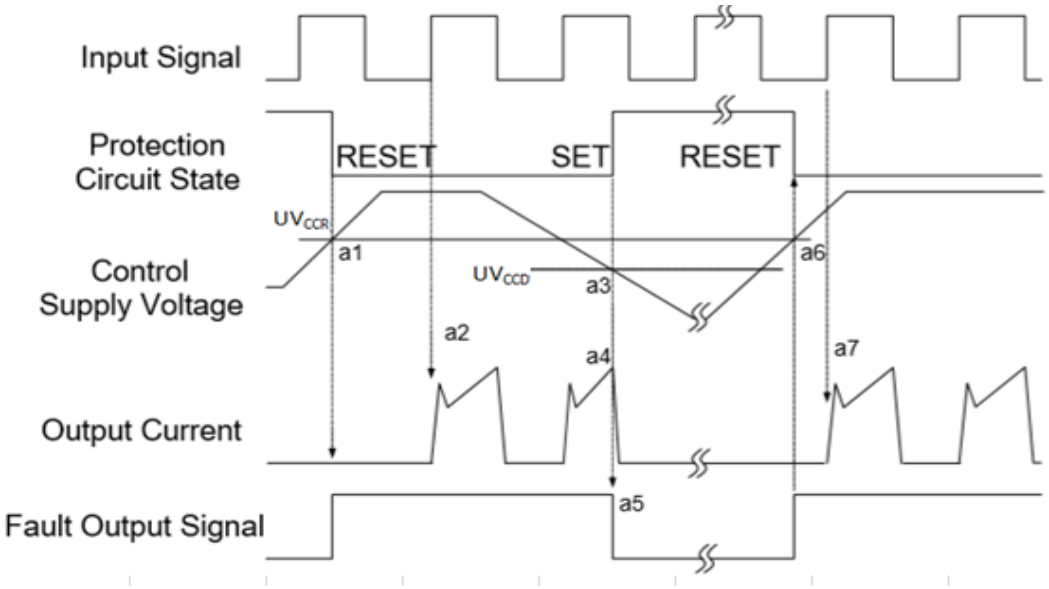


图 7：欠压保护时序图(低侧)

Fig 7：Undervoltage protection sequence diagram (low side)

a1 :电源电压上升：电压上升至 UV_{CCR},当下一个输入信号到来时电路开始工作；

a1 : Control supply voltage rises: after the voltage rises UV_{CCR}, the circuits start to operate when next input is applied.

a2: 正常运行: MOSFET 开启并加载电流。

a2: Normal operation: MOSFET turns on and loads current.

a3: 欠压检测点(UV_{CCD})。

a3: Undervoltage detection point (UV_{CCD}).

a4: 不管输入是什么信号，MOSFET 都是关闭状态。

a4: No matter what signal is input, the MOSFET is off.

a5: 故障输出开启。

a5: Fault output is on.

a6: 欠压恢复(UV_{CCR})。

a6: Undervoltage recovery (UV_{CCR}).

a7: 正常运行: MOSFET 导通并加载负载电流。

a7: Normal operation: MOSFET is turned on and load current is loaded.

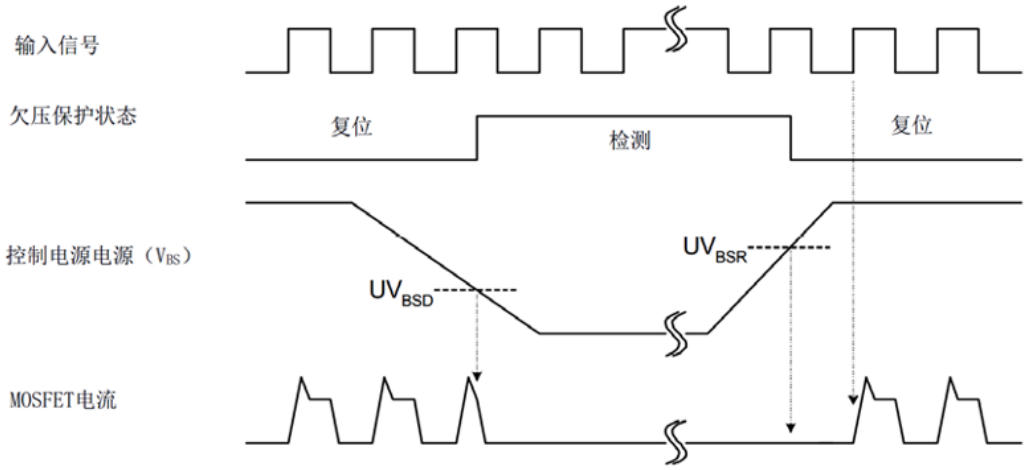


图 8：欠压保护时序图(高侧)

Fig 8：Undervoltage protection sequence diagram (High side)

b1：电源电压上升：当该电压上升到欠压恢复点，在下一个欠压信号被执行前该线路将启动运行。

b1: Power supply voltage rise: When the voltage rises to the undervoltage recovery point, the line will start running before the next undervoltage signal is executed.

b2：正常运行: MOSFET 导通并加载负载电流。

b2: Normal operation: MOSFETis turned on and load current is applied.

b3：欠压检测 (UV_{BSD})。

b3: Undervoltage detection (UV_{BSD}).

b4：不管输入是什么信号，MOSFET 都是关闭状态。

b4: No matter what signal is input, MOSFET is off.

b5：欠压恢复(UV_{BSR})。

b5: Undervoltage recovery (UV_{BSR})。.

b6：正常运行: MOSFET 导通并加载负载电流。

b6: Normal operation: MOSFET is turned on and load current is applied.

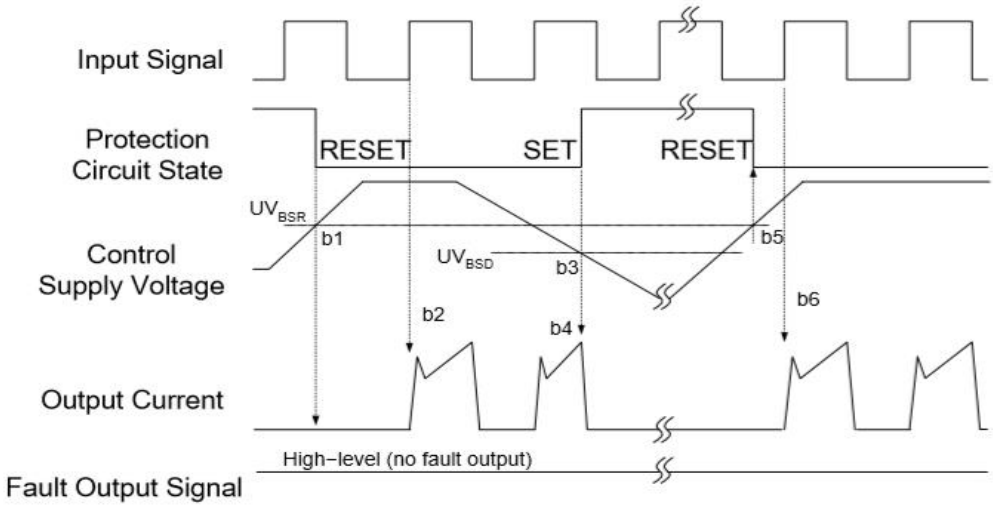


图 9：短路保护时序图

Fig 9： Short circuit protection sequence diagram

HIN :高侧输入信号；
HIN : High−side Input Signal
LIN : 低侧输入信号；
LIN : Low−side Input Signal
HO : 高侧输出信号；
HO : High−Side Output Signal
LO : 低侧输出信号；
LO : Low−Side Output Signal
CSC :过流侦测信号；
CSC : Over Current Detection Input
/FO:故障输出信号
/FO : Fault Out Function

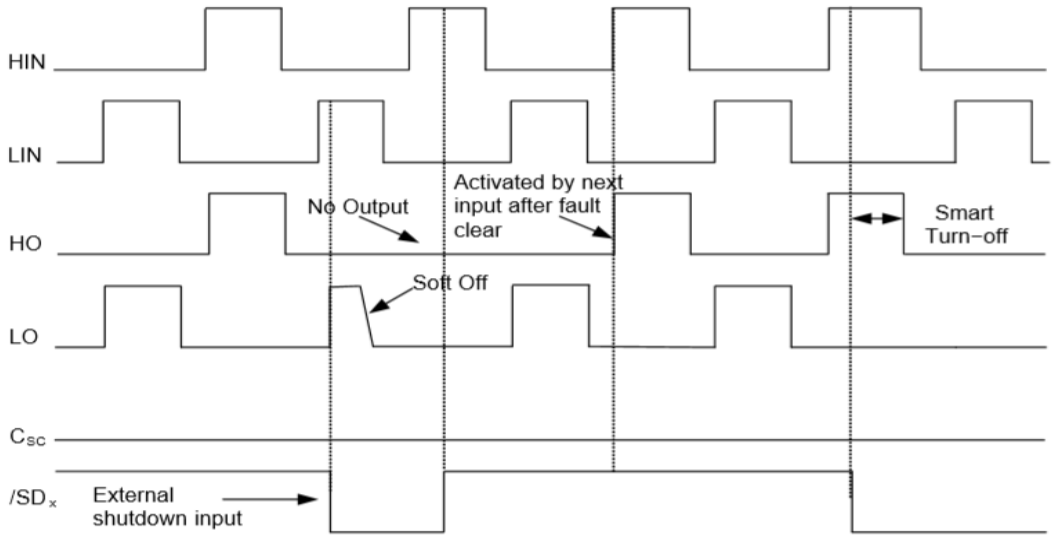


图 10. 外部关断功能时序

Figure 10. Shutdown Input Function by External Command

HIN :高侧输入信号；
HIN : High−side Input Signal
LIN : 低侧输入信号；
LIN : Low−side Input Signal
HO : 高侧输出信号；
HO : High−Side Output Signal
LO : 低侧输出信号；
LO : Low−Side Output Signal
CSC :过流侦测信号；
CSC : Over Current Detection Input
/SDx:外部关断输入信号
/SDx : Shutdown Input Function

应用电路 Application Circuit

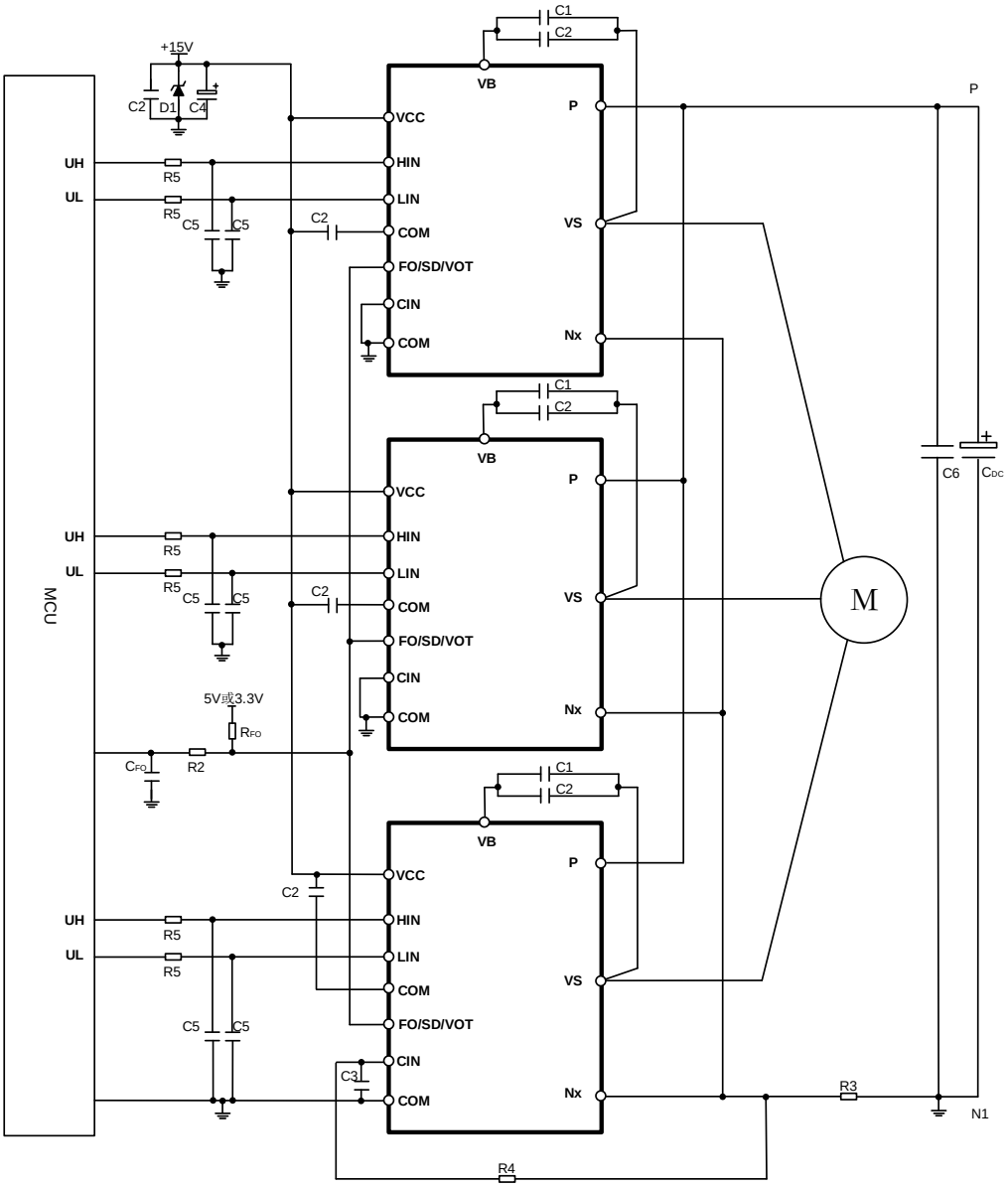


图 11：典型应用电路图

Fig 11：Example of Application Circuit

备注 4：自举电路的元器件参数要根据 PWM 周期而定，以 15kHz 开关频率为例：C1= 4.7uF，C2=0.1uF。

NOTE 4：Parameters for bootsrap circuit elements are dependent on PWM algorithm. For 15 kHz of switching frequency, typical example of parameters is an example of：C1= 4.7uF，C2=0.1uF。

备注 5：在模块的每个输入端和 MCU 输出端之间加入 RC 去耦电路，如 R5、C5，防止干扰噪声引起的信号失真。

NOTE 5：RC coupling(R5 and C5) input of IPM and MCU may be used to prevent improper signal due to surge noise. Signal input of IPM is compatible with standard CMOS or LSTTL outputs.

备注 6：输入驱动高有效；IC 内部集成有一个 500K (典型值)下拉电阻；为防止发生误动作， 输入布线应尽可能短；当用 RC 去耦线路时，须确保输入信号达到开启和关断阈值电压范围。

NOTE 6：Input drive is High-Active type. There is a 500kΩ(typ.) pull-down resistor integrated in the IC input circuit.To prevent malfunction, the wiring of each input should be as short as possible. When using RC coupling circuit, make sure the input signal level meet the turn-on and turn-off threshold voltage.

备注 7：由于 R3 位于 MOSFET 源极与 COM 之间，R3 的压降会影响到下侧 MOSFET 的开关特性以及自举电路的特性

因此 R3 的稳态压降应小于 1V。

NOTE 7：The voltage drop across R3 affects the low side switching performance and the bootstrap characteristics since it is placed between COM and the source terminal of the low side MOSFET. For this reason, the voltage drop across R3 should be less than 1V in the steady-state.

备注 8：由于模块内置了专用 HVIC，其控制端子可与 CPU 端子直接相连，而不需要任何光耦或变压器等隔离电路。

NOTE 8：Thanks for HVIC inside modules, direct coupling to MCU without any opto-coupler or transformer isolation is possible.

备注 9：自举电路负极应直接连接到 VS 端。

NOTE 9：Bootstrap negative electrodes should be connected to VS terminals directly and separated from the main output wires.

备注 10：保护线路 R4、C3 的时间常数建议选取在 1~2uS。关断时间可能随着布线的不同而多少有些变化。建议 R4、C3 选择小容差，温度补偿类型。

NOTE 10：The time constant R4、C3 of the protection circuit should be selected in the range of 1.0-2μs. SC interrupting time might vary with the wiring pattern. Tight tolerance, temp-compensated type is recommended for R4, C3.

备注 11：所有电容的位置尽可能的靠近 IPM。

NOTE 11：All capacitors should be mounted as close to the terminals of the IPM as possible.

备注 12：为了防止噪声干扰，储能电容与 P&N1 之间的引线应尽可能的短，推荐在 P&N1 端子之间加约 0.1～0.22uF 的 MLCC 低频滤波电容。

NOTE 12：To prevent surge destruction, the wiring between the smoothing capacitor and the P, N1 terminals should be as short as possible. Generally, a 0.1-0.22μF snubber between the P-N1 terminals is recommended.

外形封装图 Detailed Package Outline Drawings

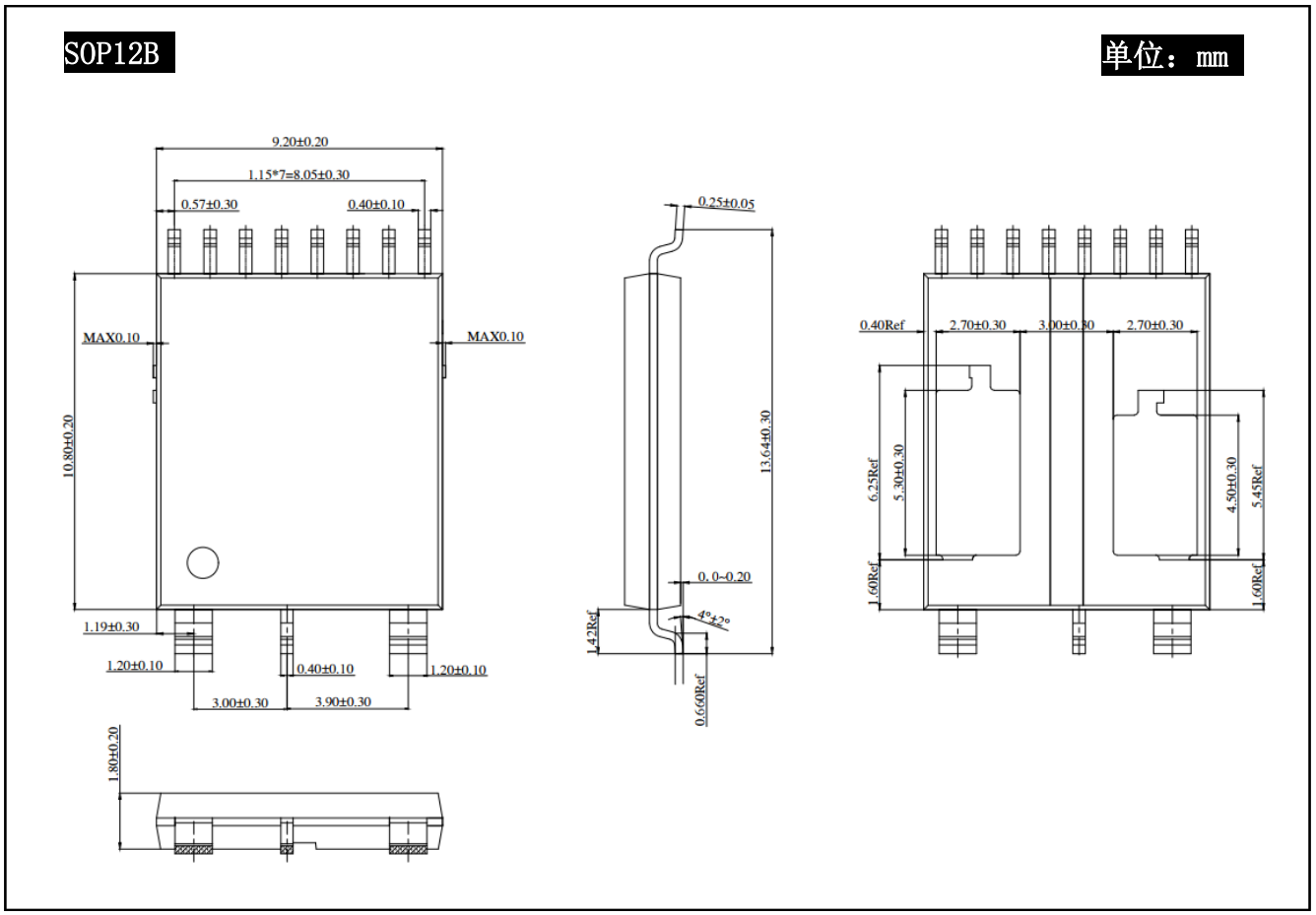


图 12：SPE03M60B-CH 封装外形图

Fig12：SPE03M60B-CH Package Outline Drawings

注意事项

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