



SPE06S60H-A

主要参数 MAIN CHARACTERISTICS

600V/6A 3 相全桥驱动	
V_{CES}	600V
I_c	6A
V_{ISO}	1500V

用途

- 风机
- 水泵
- 冰箱

APPLICATIONS

- Fan motor
- Water pump
- Refrigerator

产品特性

- 600V/6A 三相逆变器，内置低损耗沟道栅-场截止型 IGBT。
- 信号高电平有效，兼容 3.3V 和 5V 的 MCU。
- 内置自举二极管。
- 内置欠压保护、过流保护、过温保护。
- 使能关断功能。
- 恒流温度检测输出。

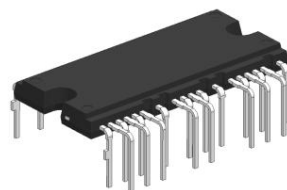
FEATURES

- 600V/6A three-phase inverter with built-in low-loss trench gate-field stop IGBT.
- Signal high level valid, compatible with 3.3v and 5V MCU.
- Built-in bootstrap diode.
- Built-in undervoltage protection、Over current protection、Over temperature protection.
- Shut-Down Input.
- Constant current temperature detection output.

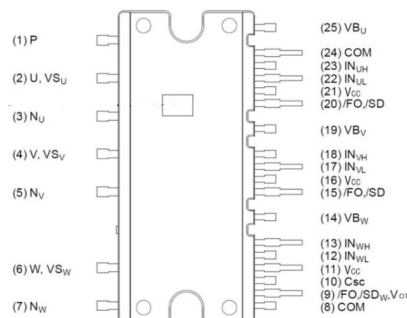
订货信息 ORDER MESSAGE

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
2A01-0866	SPE06S60H-A	N/A	SPE06S60H-A	DIP26-FP

封装 Package



DIP26-FP



PIN1-PIN25



模块分布示意图 Module distribution diagram

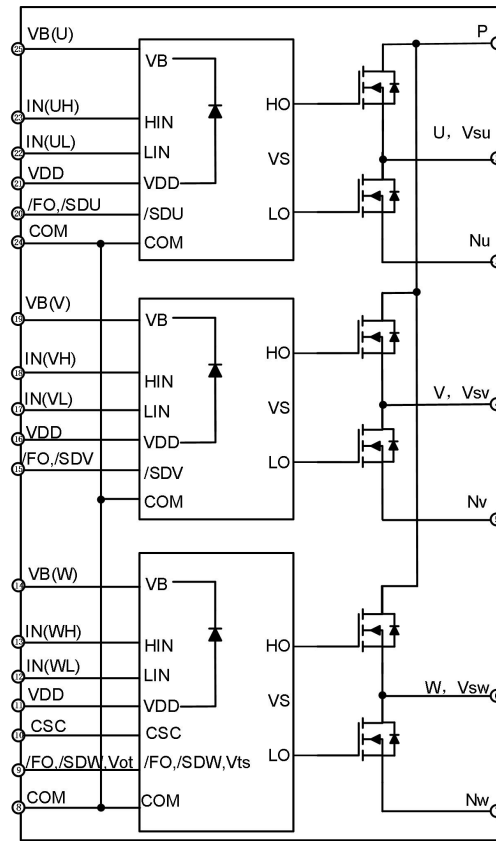


图 1：模块内部电路示意图

Fig 1: Internal circuit

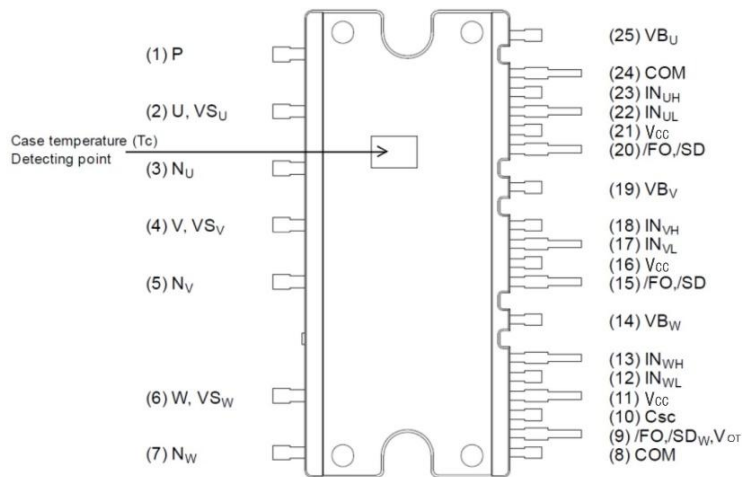


图 2：模块引脚分布示意图

Fig 2: Distribution of pin



引脚编号 Number	引脚名称 Name	引脚描述 Description
1	P	逆变器直流输入端子 Dc input terminal of inverter
2	U, VS _U	U 相输出和 U 相高侧驱动偏置电压地 Output for U-Phase & Bias Voltage Ground for U-phase High-Side Driving
3	N _U	U 相下臂 IGBT 发射极端子 U phase lower arm IGBT emitter terminal
4	V, VS _V	V 相输出和 V 相高侧驱动偏置电压地 Output for V-Phase & Bias Voltage Ground for V-phase High-Side Driving
5	N _V	V 相下臂 IGBT 发射极端子 V phase lower arm IGBT emitter terminal
6	W, VS _W	W 相输出和 W 相高侧驱动偏置电压地 Output for W-Phase & Bias Voltage Ground for W-phase High-Side Driving
7	N _W	W 相下臂 IGBT 发射极端子 W phase lower arm IGBT emitter terminal
8	COM	公共电源接地 GND Common Supply Ground
9	/FO, /SD _W , VOT	故障输出, W 相输入关闭, 温度输出 Fault Output, Shut-Down Input for W Phase, Temperature Output
10	CSC	过流和短路保护关闭输入端子 Shut Down Input for Over Current and Short Circuit Protection
11	V _{CC}	控制电源端子 Control power terminal
12	IN _{WL}	W 相下臂控制信号输入端子 W phase lower arm control signal input terminal
13	IN _{WH}	W 相上臂控制信号输入端子 W phase upper arm control signal input terminal
14	VB _W	W 相上臂驱动电源端子 W phase upper arm drive power terminal
15	/FO/SD _V	V 相输入关闭 Shut-Down Input for V Phase
16	V _{CC}	控制电源端子 Control power terminal
17	IN _{VL}	V 相下臂控制信号输入端子 V phase lower arm control signal input terminal
18	IN _{VH}	V 相上臂控制信号输入端子 V phase upper arm control signal input terminal
19	VB _V	V 相上臂驱动电源端子 V phase upper arm drive power terminal
20	/FO/SD _U	U 相输入关闭 Shut-Down Input for U Phase
21	V _{CC}	控制电源端子 Control power terminal
22	IN _{UL}	U 相下臂控制信号输入端子 U-phase lower arm control signal input terminal
23	IN _{UH}	U 相上臂控制信号输入端子 U-phase upper arm control signal input terminal
24	COM	公共电源接地 GND Common Supply Ground
25	VB _U	U 相上臂驱动电源端子 U-phase upper arm drive power terminal

图 3: 模块引脚功能定义表

Fig 3: Pin function

最大额定值 ($T_J = 25^{\circ}\text{C}$, 除非特殊说明)Absolute Maximum Ratings ($T_J = 25^{\circ}\text{C}$, Unless otherwise Specified)

逆变部分 Inverter Part

记号 Symbol	参数 Parameter	条件 Condition	额定值 Ratings	单位 Units
V_{CC}	电源电压 Power supply voltage	应用于 P- NU, NV, NW 之间 Applied between P- NU, NV, NW	450	V
$V_{CC(\text{Surge})}$	电源电压 (含浪涌) Power supply voltage (including surge)	应用于 P- NU, NV, NW 之间 Applied between P- NU, NV, NW	500	V
V_{CES}	集电极-发射极之间电压 Collector emitter Voltage of Each IGBT		600	V
$\pm I_C$	集电极电流 Each IGBT Current, Continuous	$T_C = 25^{\circ}\text{C}$,	6	A
$\pm I_{CP}$	集电极电流 (峰值) Each IGBT Pulse Current, Peak	$T_C = 25^{\circ}\text{C}$, 脉冲宽度小于 1ms $T_C = 25^{\circ}\text{C}$, Less than 1mS	12	A
P_C	集电极功耗 Maximum Power Dissipation	$T_C = 25^{\circ}\text{C}$, 单晶片 $T_C = 25^{\circ}\text{C}$, Each IGBT	15	W
T_J	结温 Junction Temperature	(见备注 1) Note1	-40~150	$^{\circ}\text{C}$

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 V_{CC} and COM	20	V
V_{BS}	高侧控制电压 High-side Bias Voltage	VB-VS 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 V_{IN} and COM	$-0.3 \sim V_{CC} + 0.3$	V
I_{FO}	故障输出电流 Fault Current	/FO, /SDW, VTS 管脚的灌电流 Sink Current at /FO, /SDW, VTS Pin	2	mA
V_{SC}	电流检测端输入电压 Input voltage of current detection terminal	应用于 CSC- COM 之间 Applied between CSC-COM	$-0.3 \sim V_D + 0.3$	V
V_{FO}	故障输出电压 Fault output voltage	应用于 FO - COM之间 Applied between FO-COM	$-0.3 \sim V_D + 0.3$	V

整个系统 Total System

记号 Symbol	参数 Parameter	条件 Condition	额定值 Ratings	单位 Units
$V_{PN(\text{PROT})}$	自我保护电源电压限制 Self-protecting power supply voltage limit	$V_{CC} = V_{BS} = 13.5\text{V} \sim 16.5\text{V}$, $T_J = 125^{\circ}\text{C}$, 非重复性, $< 2\mu\text{s}$	400	V
T_C	模块壳体工作温度 Module shell temperature		-20~100	$^{\circ}\text{C}$





T _{STG}	贮存温度 Storage Temperature	T _C =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	V _{rms}

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

Note 1: The maximum rated junction temperature of the IPM power chip is 150° C (@surface temperature T_C ≤ 100° C). However, to ensure safe operation of the IPM, the junction temperature should be limited to T_{J(av)} ≤ 125° C (@surface temperature T_C ≤ 100° C)

热阻 Thermal Resistance

记号 Symbol	参数 Parameter	条件 Condition	额定值 Ratings	单位 Units
R _{th(j-c)Q}	结到外壳的热阻 Junction to Case Thermal resistance	逆变器工作条件下的单个IGBT Each IGBT	7.6	℃/W
R _{th(j-c)F}	结到外壳的热阻 Junction to Case Thermal resistance	逆变器工作条件下的单个FRD Each FRD	7.8	℃/W

备注 2: 关于壳体温度 (T_C) 的测量点, 参见图 2。

Note 2: For the measurement point of shell temperature (T_C), see Figure 2.

电气特性 (T_J=25℃, 除非特殊说明)

Electrical Characteristics (T_J=25℃, Unless Otherwise Specified)

逆变部分 Inverter 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
V _{CE(SAT)}	集电极-发射极间饱和电压 Collector - emitter saturation voltage	V _D =V _{DB} =15V, I _C =6A, T _J =25℃, V _{IN} =5V	-	1.6	2.3	V
		I _C =6A, T _J =125℃,	-	2.1	-	
V _F	FRD正向电压 FRD Forward voltage	V _{IN} = 0V, I _C =-6A,	-	1.7	2.3	V
I _{CES}	集电极-发射极间漏电流 Collector emitter leakage current	V _{CE} =V _{CES}	-	-	1	mA
t _{ON}	开关时间 (备注3) Switching Times(Note 3)	V _{PN} = 400 V, V _D = V _{DB} = 15 V, I _C =6 A V _{IN} = 0 V ↔ 5 V, 电感负载 / Inductive Load	-	550	-	nS
t _{C(ON)}			-	230	-	
t _{OFF}			-	500	-	
t _{C(OFF)}			-	75	-	
trr			-	170	-	

备注 3: t_{ON} 和 t_{OFF} 包括驱动 IC 内部传输延迟时间。t_{C(ON)} 和 t_{C(OFF)} 是 IGBT 自身被内部给定门极驱动条件下的开关时间。详见图 3。

Note 3: t_{ON} and t_{OFF} include the internal propagation delay time of the driver IC. t_{C(ON)} and t_{C(OFF)} are the switching times of the IGBT itself driven by the internally given gate. See Figure 3 for details.





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}	VCC 静态电流 Quiescent VCC Supply Current	VCC=15V VIN=5V	VCC-COM 之间 Applied between VCC and COM	-	-	500	uA
I _{QB}	VBS 静态电流 Quiescent VBS Supply Current	VDB=15V VIN=5V	VB(U)-U, VB(V)-V, VB(W)-W 之间 Applied between VB(U)-U, VB(V)-V, VB(W)-W	-	-	200	uA
V _{FOH}	故障输出电压 Fault Out Voltage	VSC=0V, /FO Circuit: 6.8K to 5V pull-up		4.2	-	-	V
V _{FOL}		VSC=1V, /FO Circuit: 6.8K to 5V pull-up		-	-	0.5	
V _{sc (ref)}	短路保护触发电压 Short circuit trip level	VCC=15V		0.40	0.45	0.51	V
t _{FO}	故障清除脉冲宽度 Fault output pulse width	-		20	-	-	us
UV _{CCD}	低侧欠压保护 Low-Side Under-Voltage Protection	检测电平 VCC Under-Voltage Protection Detection Level		7.4	8.2	9.0	V
UV _{CCR}		复位电平 VCC Under-Voltage Protection Reset Level		8.0	9.2	10.0	V
UV _{BSD}	高侧欠压保护 High-Side Under-Voltage Protection	检测电平 VBS Under-Voltage Protection Detection Level		7.5	7.9	8.5	V
UV _{BSR}		复位电平 VBS Under-Voltage Protection Reset Level		8.0	8.6	9.5	V
I _{FO_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	-	
V _{FO_T}	HVIC 温度检测输出电压 HVIC Temperature Sensing Voltage Output	VDD=VBS=15V,T=25℃, 10K to 5V Pull-up		-	4.18	-	V
		VDD=VBS=15V,T=75℃, 10K to 5V Pull-up		-	2.93	-	
V _{IH}	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		-	-	2.5	V
V _{IL}	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	-	-	V
R _{BSD}	自举二极管限流电阻 Bsd resistance			-	100	-	ohm

备注 4: IPM 的 VOT 输出特性曲线请参考图 4.1, 图 4.2 曲线是以 10KΩ 上拉电阻至 5V 和以 4.7 KΩ 上拉电阻至 3.3V 测试结果。

Note 4: Please refer to figure 4.1 for the VOT output characteristic curve of IPM. The curve in Figure 4.2 shows the test results of 10 KΩ pull-up resistance to 5V and 4.7 KΩ pull-up resistance to 3.3V.





推荐工作条件 Recommended Operating Conditions

记号 Symbol	参数 Parameter	条件 Condition	最小值 Min.	典型值 Typ.	最大值 Max.	单位 Unit
V_{PN}	电源电压 Supply Voltage	施加在P和N之间 Between P and N	-	300	400	V
V_{CC}	控制电源电压 Control Supply Voltage	施加在 V_{CC} 和 COM之间 Between V_{CC} and COM	13.5	15.0	16.5	V
V_{BS}	高端偏压 High-Side Bias Voltage	施加在 V_B 和 V_S 之间 Between V_B and V_S	13.5	15.0	16.5	V
dV_{CC}/dt , dV_{BS}/dt	控制电源波动 Control power fluctuation	-	-1	-	1	V/us
t_{dead}	防止桥臂直通的死区时间 Blanking Time for Preventing Arm-Short	$V_{CC} = V_{BS} = 13.5 \sim 16.5 \text{ V}$, $T_j \leq 150^\circ\text{C}$	1.0	-	-	us
F_{PWM}	PWM 开关频率 PWM Switching Frequency	$T_j \leq 150^\circ\text{C}$	-	-	20	KHz
PWM	最小输入信号脉冲宽度 Minimum input signal pulse width	$P_{WIN(ON)}$	0.7	-	-	us
		$P_{WIN(OFF)}$	0.7	-	-	us
COM	COM 电压波动 COM voltage fluctuation	COM 和 NU, NV, NW 之间 (包括浪涌) Between COM and NU, NV, NW (Including surge voltage)	-5	-	+5	V

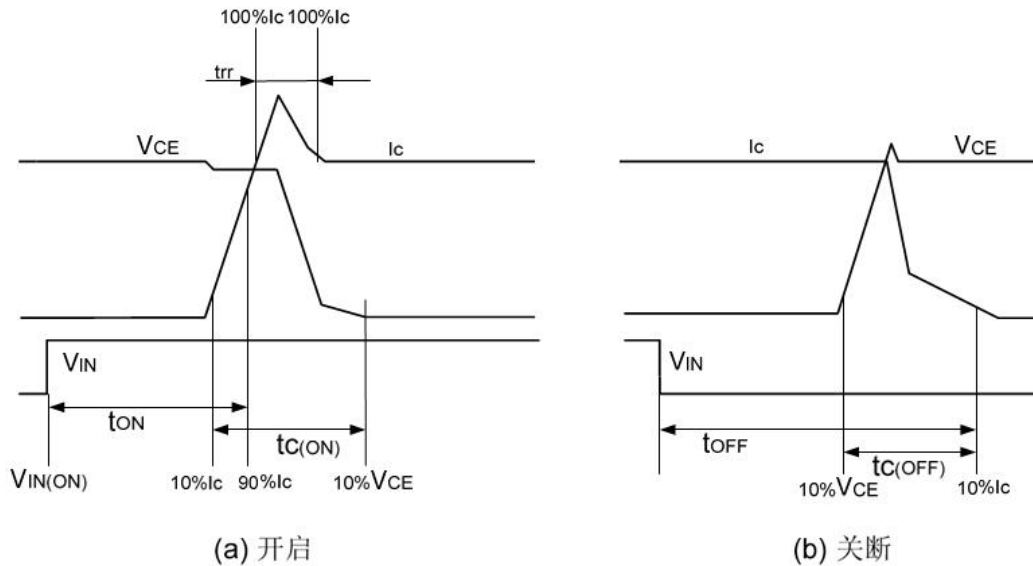


图 3: 开关时间定义

Fig 3: Switching Time Definition

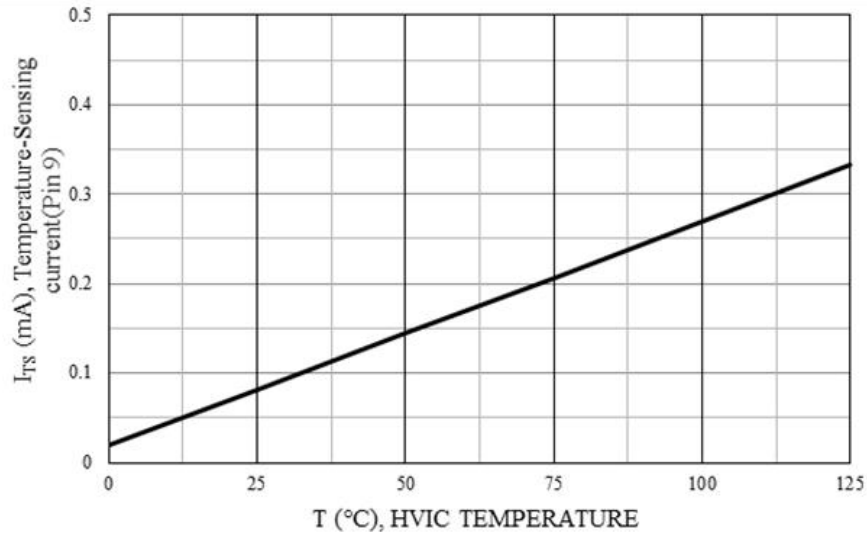


图 4.1: HVIC 温度检测输出温度—电流曲线

Fig 4.1: Curves of HVIC Temperature-Current Output

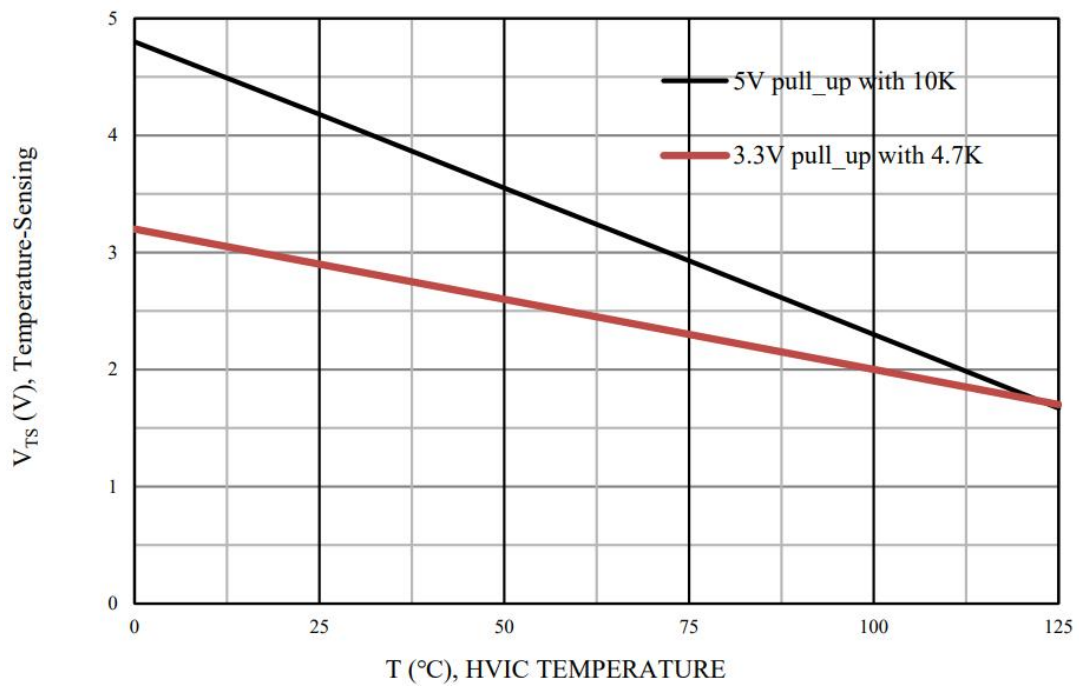


图 4.2: HVIC 温度检测输出温度—电压曲线

Fig 4.2: Curves of HVIC Temperature detection-voltage curve

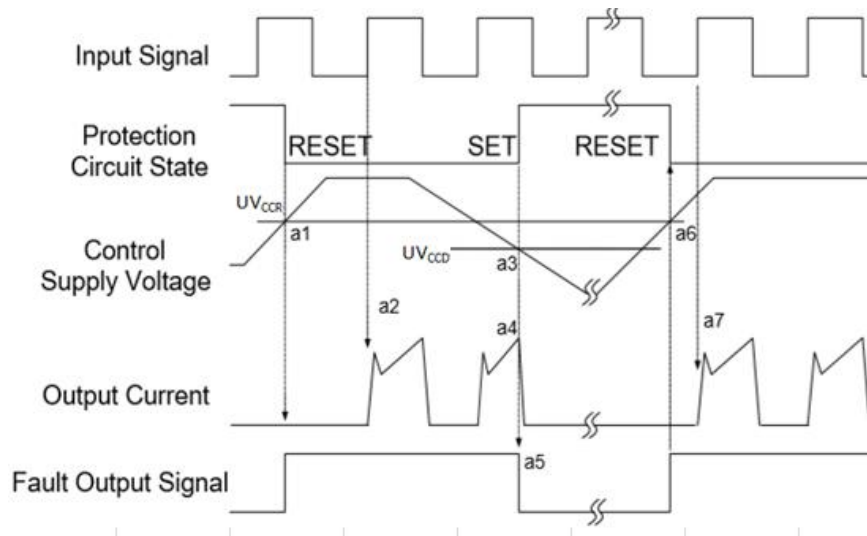


图 5: 欠压保护时序图(低侧)

Fig 5: 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: IGBT 开启并加载电流。

a2: Normal operation: IGBT 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, IGBT 都是关闭状态。

a4: No matter what signal is input, the IGBT 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: IGBT 导通并加载负载电流。

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

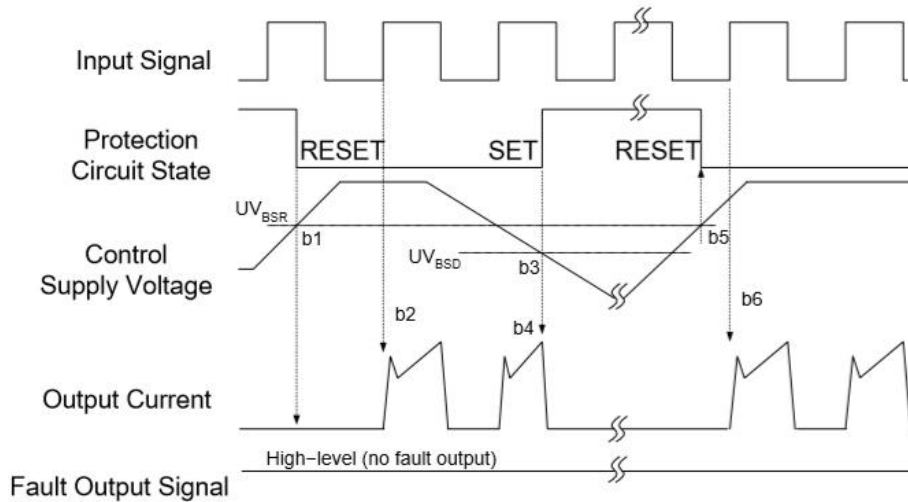


图 6: 欠压保护时序图(高侧)

Fig 6: 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: IGBT 导通并加载负载电流。

b2: Normal operation: IGBT is 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, IGBT 都是关闭状态。

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

b5: 欠压恢复(UV_{BSR})。

b5: Undervoltage recovery (UV_{BSR})。

b6: 正常运行: IGBT 导通并加载负载电流。

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

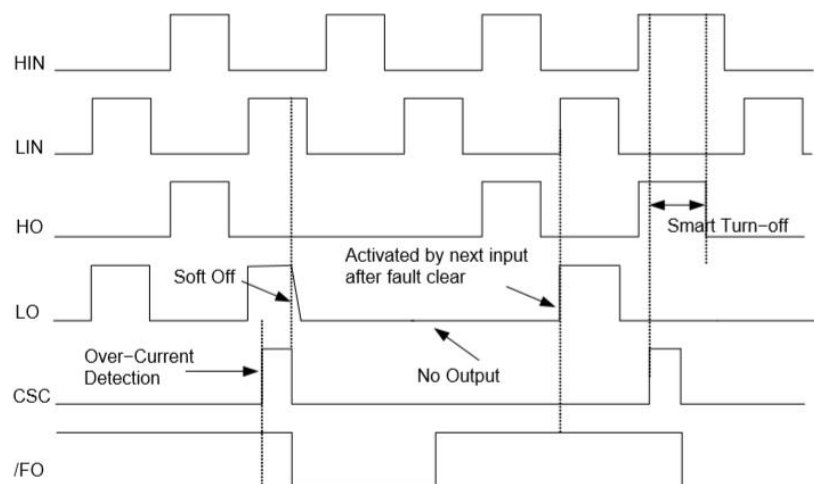


图 7: 过流保护时序

Fig 7: Fault-Out Function by Over Current Protection

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

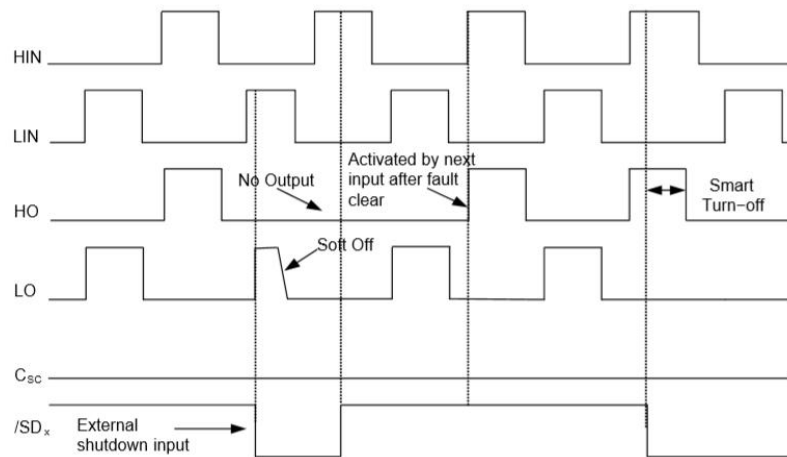


图 8. 外部关断功能时序

Figure 8. 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

输入输出接口电路 Input/output interface circuit

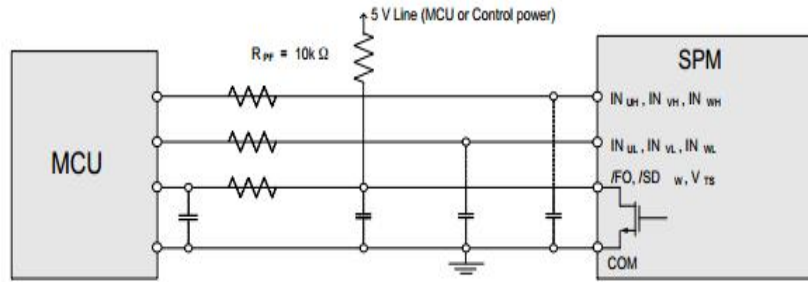


图 9. 推荐的 MCU I/O 接口电路

Figure 9: Recommended MCU input and output interface circuit

备注 5: 由于 PWM 的控制方式和实际应用电路的阻抗及线路板的阻抗, RC 去耦可能会有变化。

Note 5 : Due to the PWM control method and the impedance of the actual application circuit and the impedance of the circuit board, RC decoupling may change.

应用电路 Application Circuit

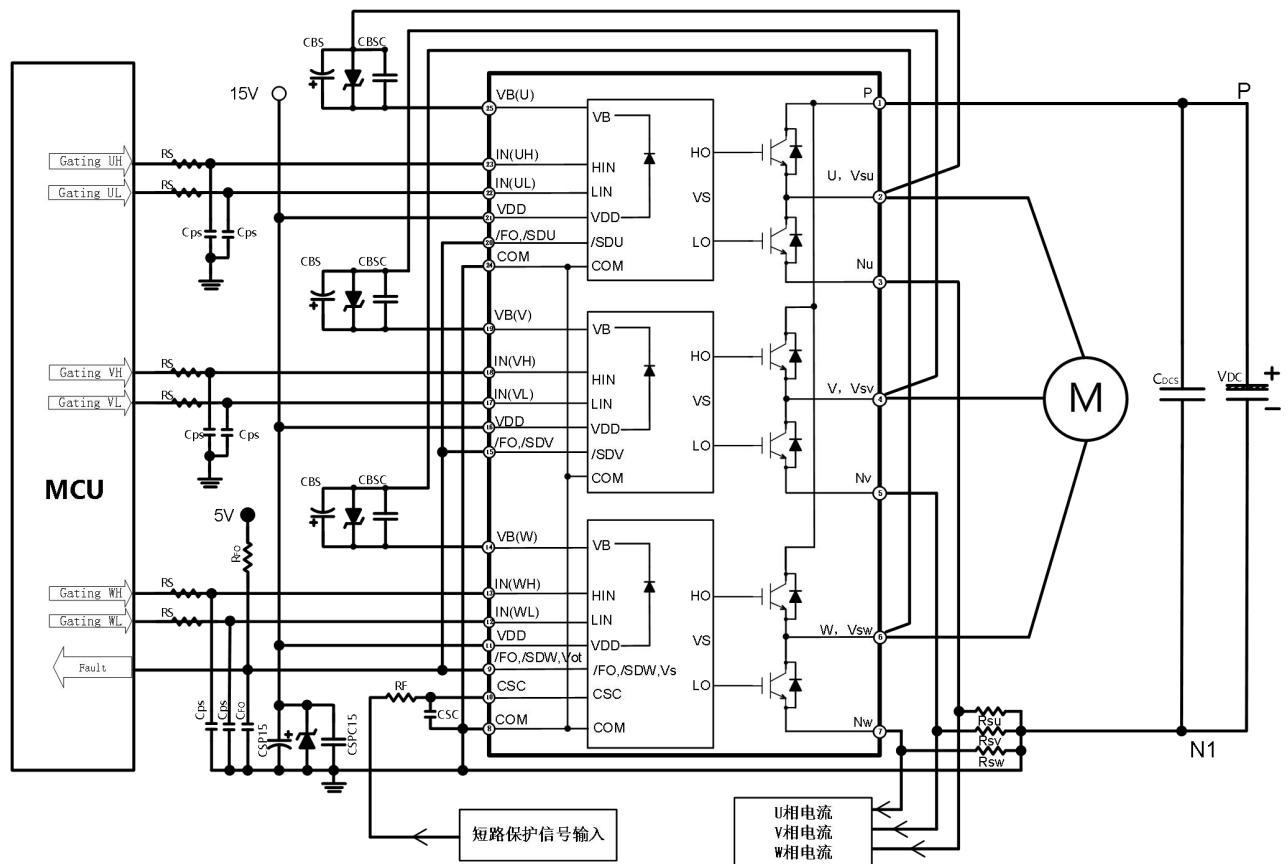


图 10: 典型应用电路图

Fig 10: Example of Application Circuit

备注 6: .关于引脚的位置请参阅图 1.

Note 6: Refer to figure 1 for pin location.

备注 7:为避免故障，各输入接线应尽可能短。

Note 7:To avoid malfunction, the wiring of each input should be as short as possible

备注 8:为防止浪涌损坏，PN 之间建议增加一个高频非感性平复电容（ $0.1\mu\text{F}\sim 0.22\mu\text{F}$ ）,电容的连线要尽量短。

Note 8:To prevent surge destruction, it is recommended to add a high-frequency non inductive smoothing capacitor （ $0.1\mu\text{F}\sim 0.22\mu\text{F}$ ） between PN, and the wiring of the capacitor should be as short as possible.

备注 9:输入信号高电平有效，在 HVIC 每个通道的输入端都有一个下拉电阻连接到地；建议在输入端增加 RC 滤波电路来防止输入信号振荡。

Note 9: The high level of the input signal is effective, and a pull-down resistor is connected to the ground at the input terminals of each channel of HVIC; It is suggested to add RC filter circuit at the input terminals to prevent input signal oscillation.

备注 10:所有电容的位置尽可能的靠近 IPM。

Note 10: Position all capacitors as close to IPM as possible.

备注 11:控制地线和电源地线要连接在一个点，走线尽量短；

Note 11:The control ground wire and power ground wire shall be connected at one point, and the wiring shall be as short as possible;

备注 12.在短路保护电路，请选择时间常数在 $1.5\sim 2\mu\text{s}$ 范围内的 RF 和 CSC,同时 RF 和 CSC 周边的接线都应尽量短，RF 接线应靠近分流电阻；

Note 12:In the short-circuit current protection circuit, please select the RF CSC time constant in the range $1.5\sim 2\mu\text{s}$,At the same time, the wiring around RF and CSC shall be as short as possible, and RF wiring shall be close to shunt resistance;

备注 13./FO,/SD 的连线尽可能短。

Note 13:/FO and /SD must be connected as short as possible.

产品机械特性

项目	条件		Min.	Typ.	Max.	单位
平面度			-50		100	μm
安装扭矩	固定螺钉：M3	建议0.7 N·m	0.5	0.6	0.7	N·m

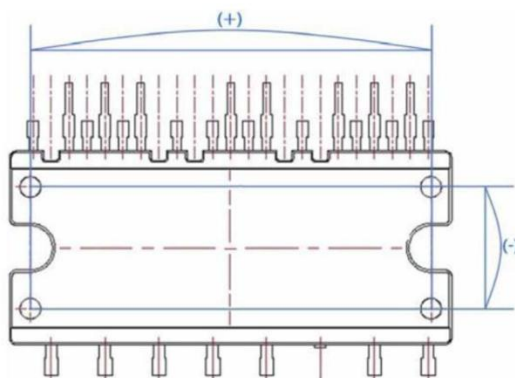


图 11 平面度测量位置

散热器安装方法及注意事项

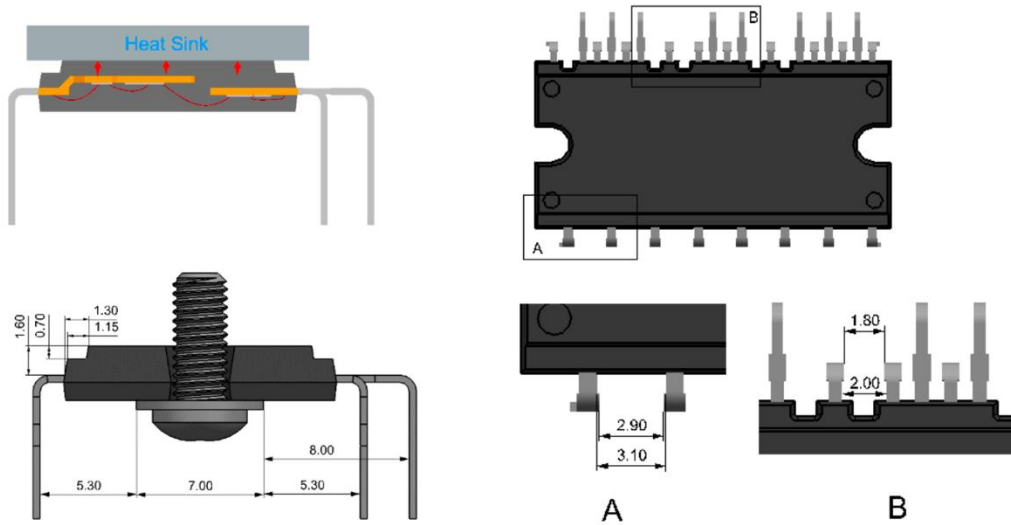
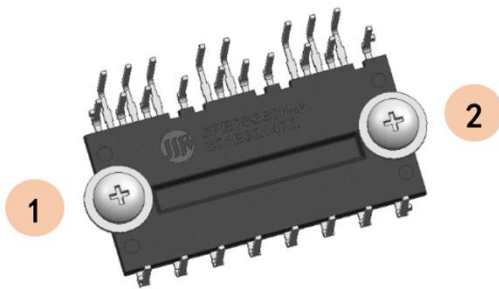


图 12-1 产品安装关键尺寸

将 IPM 安装至散热片时，请参照如下图 11-2 推荐的加固顺序。如加固用转矩过大，可能导致芯片损坏或者劣化。



建议：

预拧紧：1 → 2

最终拧紧：2 ← 1

注意：

预拧紧转矩为最大额定转矩的
20-30%

图 12-2 产品安装关键尺寸

图 12-3 所示为散热片平整度的测量位置，保证散热片表面粗糙度精整至 $10\mu\text{m}$ 以内，两螺丝孔之间平坦度（弯曲度）为 0 至 $+100\mu\text{m}$ 之间，如果散热片表面有凹坑的话，散热片与 IPM 之间会出现间隙，造成冷却效果下降，如果平坦度比 $+100\mu\text{m}$ 更大的话，IPM 会变形，导致内部绝缘基板会出现开裂。

为有效散热，在元件与散热片的接触表面上，均匀涂抹具有良好导热性能的 $+50\mu\text{m}$ 左右的散热硅脂。

外部散热片

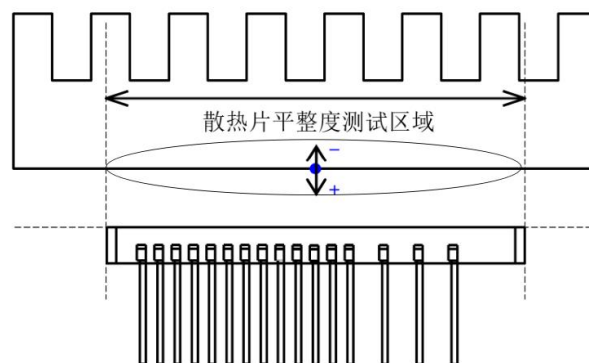


图 12-3 散热片平整度测试图

外形封装图 Detailed Package Outline Drawings

SPE06S60H-A (DIP26-FP)

单位: mm

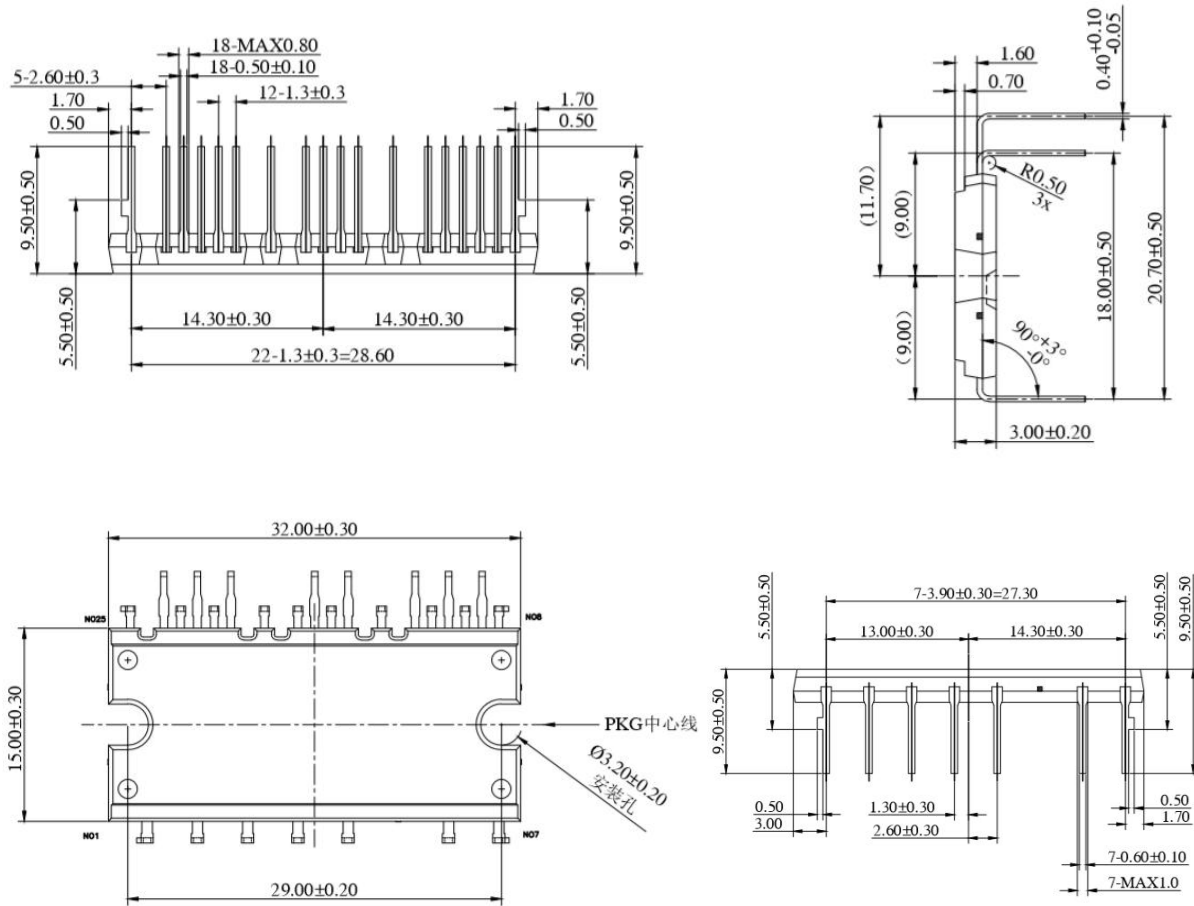


图 11: SPE06S60H-A 封装外形图

Fig 11: SPE06S60H-A Package Outline Drawings



注意事项

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3. 在电路设计时请不要超过器件的绝对最大额定值，否则会影响整机的可靠性。
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