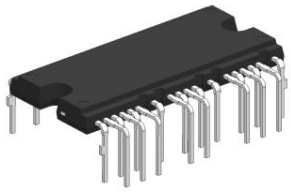
SPE04M60H-AG

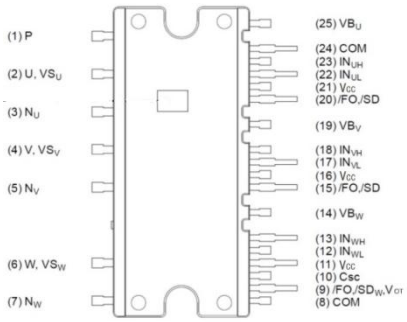
主要参数 MAIN CHARACTERISTICS

3 相全桥驱动	
V_{DSS}	600V
I_D	3A
V_{ISO}	1500V

封装 **Package**



DIP26-FP



PIN1-PIN25

用途 APPLICATIONS

- 风机 Fan motor
- 水泵 Water pump
- 油烟机 Lampblack machine
- 风扇 Electric fan

产品特性

- 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
- 温度检测输出
- 绝缘耐压 1500V

FEATURES

- 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
- Temperature detection output.
- Resistant to high voltage 1500V.

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
2A01-0864	SPE04M60H-AG	N/A	SPE04M60H-AG	DIP26-FP

模块分布示意图 Module distribution diagram

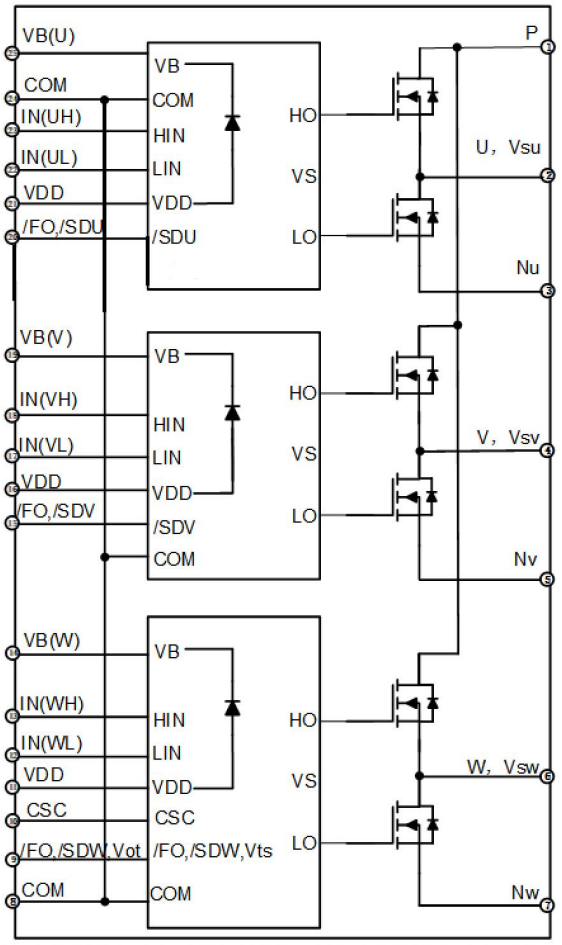


图 1：模块内部电路示意图

Fig 1: Internal circuit

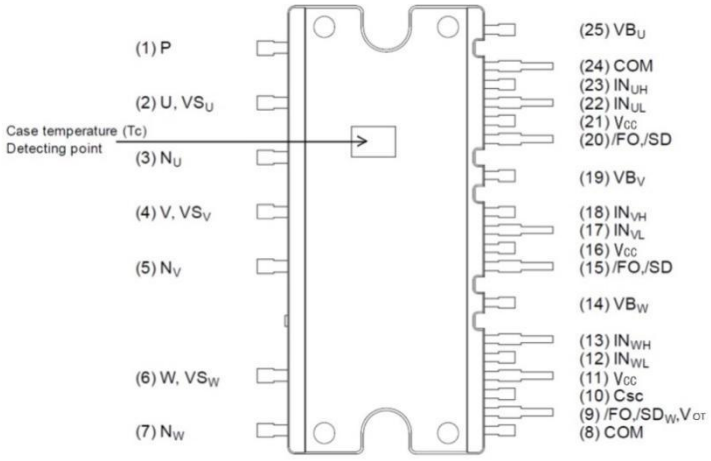


图 2：模块引脚分布示意图

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 MOSFET 源极端子 U phase lower arm MOSFET source 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 MOSFET 源极端子 V phase lower arm MOSFET source 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 MOSFET 源极端子 W phase lower arm MOSFET source terminal
8	COM	公共电源接地 GND Common Supply Ground
9	/FO, /SDW,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℃,除非特殊说明）

Absolute Maximum Ratings （T_j= 25℃, 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_{PN}	电源电压 Power supply voltage	应用于 P- NU, NV, NW 之间 Applied between P- NU, NV, NW	450	V
$V_{PN\ (Surge)}$	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
VDSS	漏-源电压 Drain-Source Voltage of Each MOSFETT		600	V
I_D	漏极连续电流 Each MOSFET Current, Continuous	T_C= 25°C,	3	A
I_{DM}	漏极电流（峰值） Each MOSFET Pulse Current, Peak	Tc=25°C, 脉冲宽度小于 100us Tc=25°C, less than 100us	6	A
P_D	最大耗散功耗 Maximum Power Dissipation	TC = 25°C， 单晶片 TC = 25°C，Each MOSFET	15.6	W
T_J	结温 Junction Temperature	(见备注 1) Note1	-40~150	°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	VCC-COM 之间 Applied between VCC 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	VIN-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 V_{FO} 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 V_{SC} and COM	-0.3~V_{CC}+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
$V_{PN(PROT)}$	自我保护电源电压限制 Self-protecting power supply voltage limit	V_{CC}=V_{BS}=13.5V~16.5V, T_j=125° C, 非重复性, ＜2us	400	V
T_C	模块壳体工作温度 Module shell temperature		-20~100	℃
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

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). However, to ensure safe operation of the IPM, the junction temperature should be limited to Tj(av) ≤ 125° C (@surface temperature TC≤ 100° C)

热阻 Thermal Resistance

记号 Symbol	参数 Parameter	条件 Condition	额定值 Ratings	单位 Units
Rth(j-c)	结到外壳的热阻 Junction to Case Thermal resistance	每个 MOSFET For Each MOSFET	8.0	℃/W

备注 2: 关于壳体温度（TC）的测量点，参见图 2。

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

电气特性 (Tj=25℃, 除非特殊说明)

Electrical Characteristics (TJ=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
BV_{DSS}	漏-源击穿电压 Drain-Source Breakdown Voltage	V_{IN}=0V, I_D=1mA	600	-	-	V
I_{DSS}	零栅极电压漏极电流 Zero Gate Voltage Drain Current	V_{IN}=0V, V_{DS}=600V	-	-	1	mA
V_{SD}	源-漏二极管正向电压 Drain-Source Diode Forward Voltage	V_{CC}=V_{BS}=15V, V_{IN}=0V, I_D=-1A	-	0.9	-	V
$R_{DS(on)}$	漏-源导通电 Drain-Source Turn-On Resistance	V_{CC}=V_{BS}=15V, V_{IN}=5V, I_D=1A	-	2.2	-	ohm
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=4 A V_{IN}= 0 V ↔5 V, 电感负载 / Inductive Load	-	500	-	nS
t_{OFF}			-	600	-	nS
t_{rr}			-	100	-	nS
E_{ON}			-	170	-	uJ
E_{OFF}			-	16	-	uJ

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 MOSFET 自身被内部给定门极驱动条件下的开关时间。详见图 4。

Note 3: t_{ON} and t_{OFF} include the internal transmission delay time of the driver IC. $t_{C(ON)}$ and $t_{C(OFF)}$ are the switching times of the MOSFET itself driven by the internally given gate. See Figure 4 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
$V_{SC(ref)}$	短路保护触发电压 Short-Circuit Trip Level	VDD = 15 V（备注 4） (Note 4)		0.39	0.44	0.50	V
t_{FOD}	故障输出脉冲宽度 Fault-Out 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	8.9	V
UV_{CCR}		复位电平 VCC Under-Voltage Protection Reset Level		8.0	9.2	9.9	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
IFO_T	HVIC 温度检测输出电流 HVIC Temperature Sensing Current Output	VDD=VBS=15V,T=25℃（备注 5）		-	82.5	-	uA
		VDD=VBS=15V,T=75℃（Note 5）		-	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_{FSDR}	使能关断复位电平 Shut-down Reset level	SDx-COM		1.7	2.2	2.5	V
V_{FSDD}	使能关断阈值电压 Shut-down Detection level	SDx-COM		0.8	1.3	1.6	V
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		-	-	3.0	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_{BS}	自举二极管阻值 Bootstrap Diode Resistance	集成在 HVIC 内 Integrated Within HVIC		-	100	-	Ω

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。

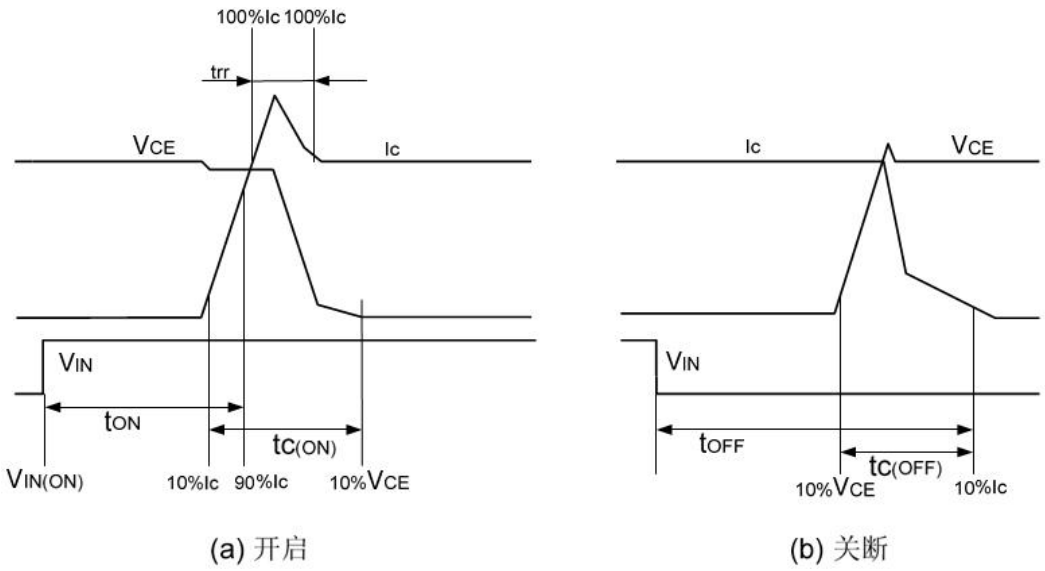
Note 4: If pins /FO,/SDW,/VTS, and other SDX are connected together, short-circuit (overcurrent) protection is effective for all six MOSFETs.

备注 5:IPM 的 VOT 输出特性曲线请参考图 5.2，图 5.2 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 5: Please refer to figure 5.2 for the VOT output characteristic curve of IPM. The curve in Figure 5.2 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	18.5	V
dV_{CC}/dt, dV_{BS}/dt	控制电源波动 Control power fluctuation		-1	-	1	V/us
$V_{IN(ON)}$	输入的开启电压 ON Threshold Voltage	施加在V_{IN}和COM之间 Applied between Vin-COM	3.0	-	V_{CC}	V
$V_{IN(OFF)}$	输入的关闭电压 OFF Threshold Voltage	施加在V_{IN}和COM之间 Applied between Vin-COM	0	-	0.8	V
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 ~ 16.5 V, Tj ≤150°C	1.0	-	-	us
F_{PWM}	PWM 开关频率 PWM Switching Frequency	Tj ≤150°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



(a) 开启 (b) 关断

图 4：开关时间定义

Fig 4: Switching Time Definition

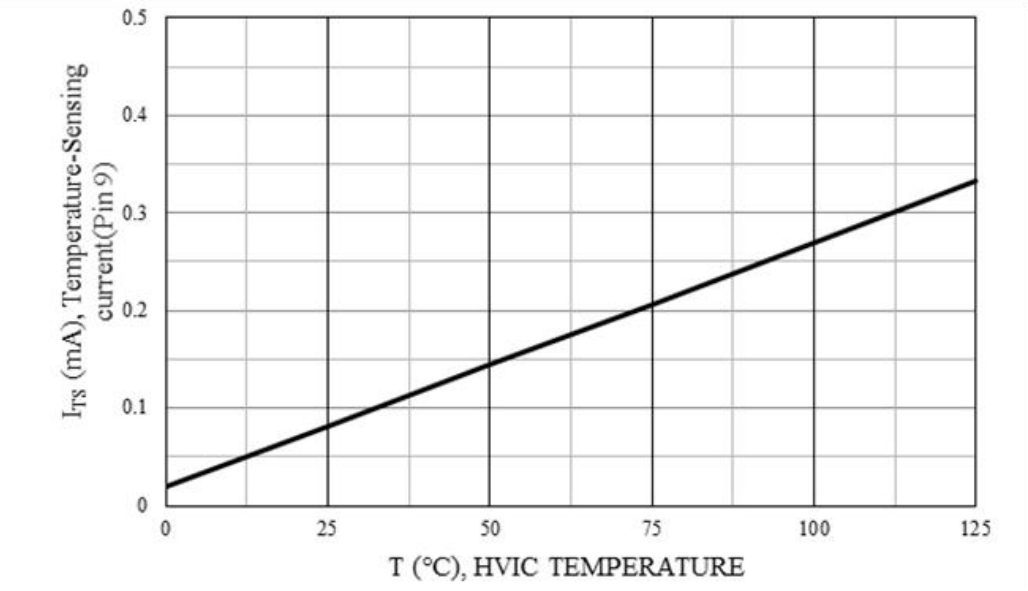


图 5.1：HVIC 温度检测输出温度—电流曲线

Fig 5.1：Curves of HVIC Temperature-Current Output

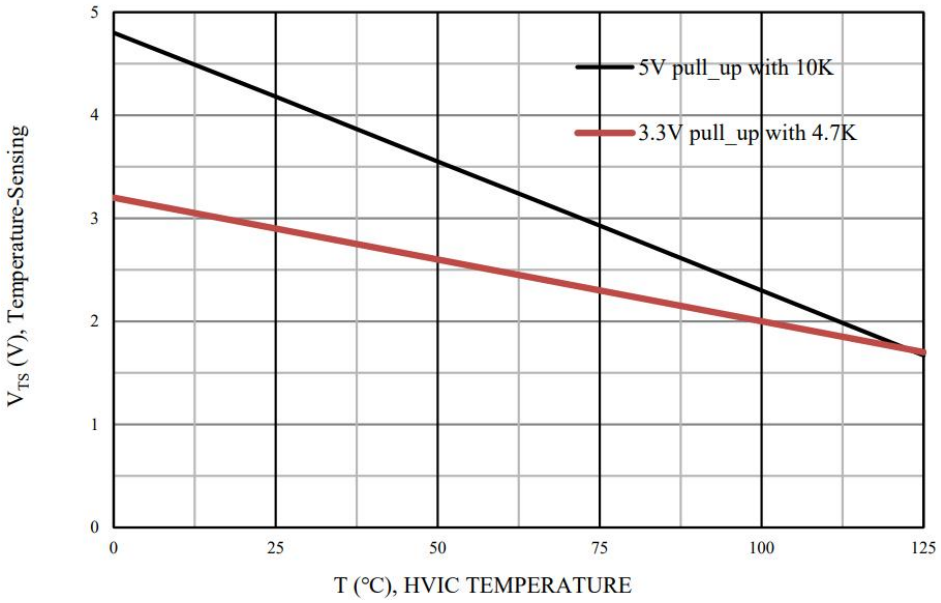


图 5.2：HVIC 温度检测输出温度—电压曲线

Fig 5.2：Curves of HVIC Temperature detection-voltage curve

保护功能时序图 Time Charts of Protective Function

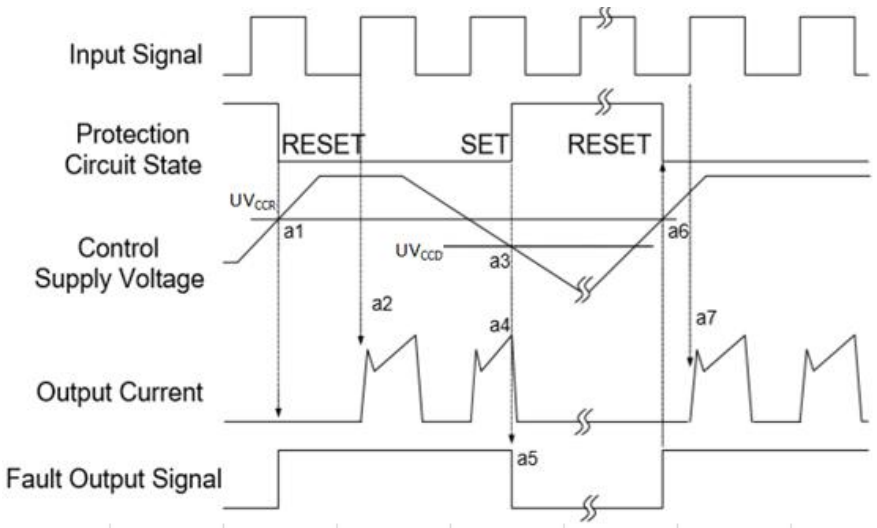


图 6：欠压保护时序图(低侧)

Fig 6：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.

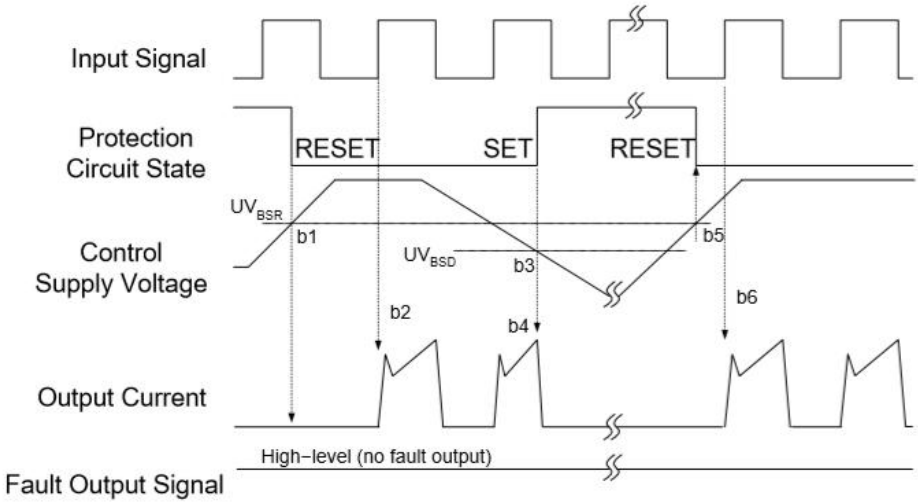


图 7：欠压保护时序图(高侧)

Fig 7：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: MOSFET 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，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.

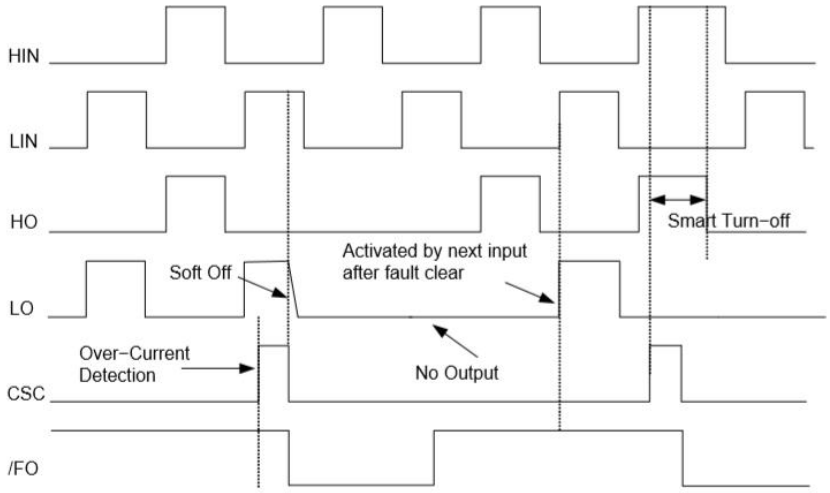


图 8：过流保护时序

Fig 8：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

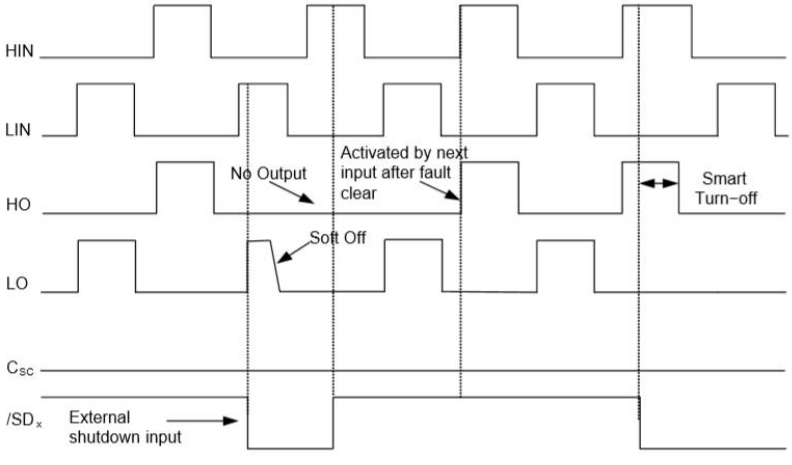


图 9. 外部关断功能时序

Figure 9. 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**

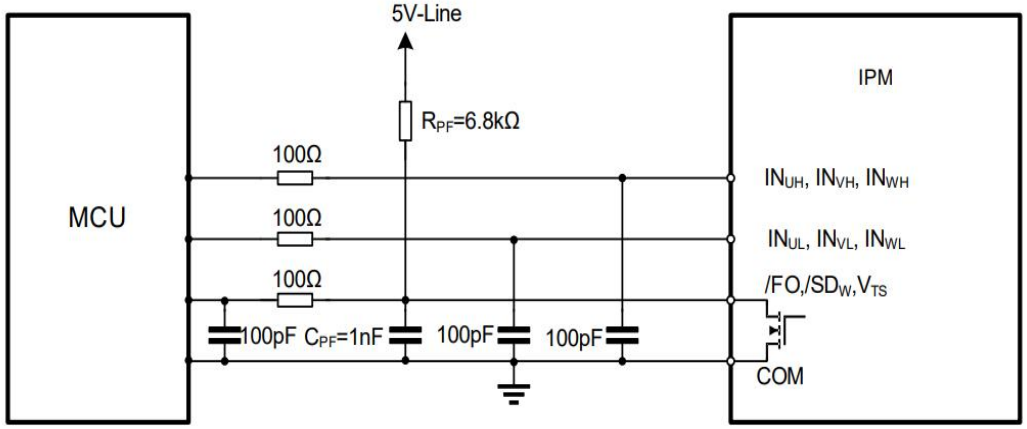


图 10. 推荐的 MCU I/O 接口电路
Figure 10: Recommended MCU input and output interface circuit

备注 6：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 6 : 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

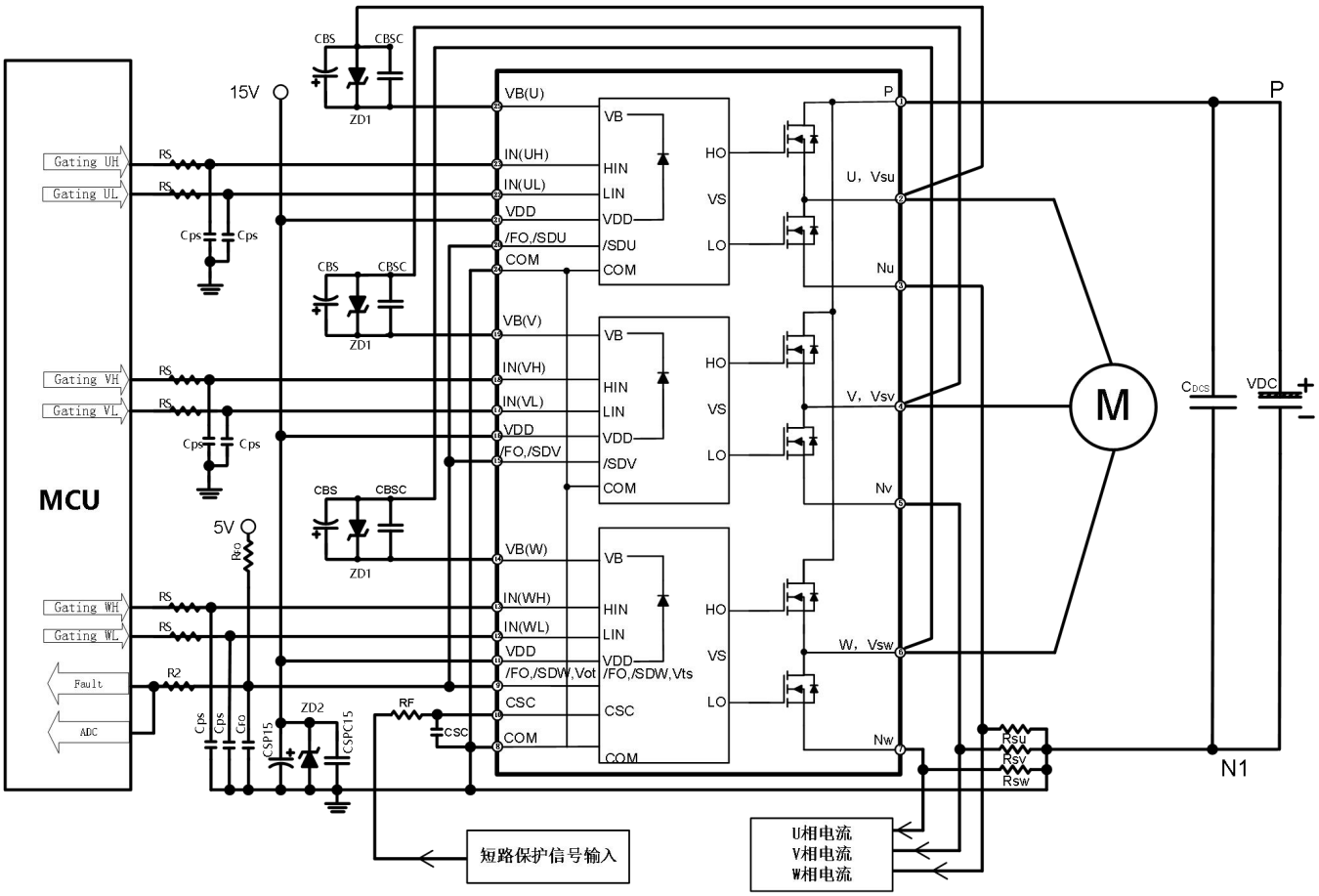


图 11：典型应用电路图

Fig 11：Example of Application Circuit

备注 7：.关于引脚的位置请参阅图 1.

Note 7: Refer to figure 1 for pin location.

备注 8:为避免故障，各输入接线应尽可能短。

Note 8:To avoid malfunction, the wiring of each input should be as short as possible

备注 9:为防止浪涌损坏，PN 之间建议增加一个高频非感性平缓电容（0.1μF～0.22μF）,电容的连线要尽量短。

Note 9:To prevent surge destruction, it is recommended to add a high-frequency non inductive smoothing capacitor （0.1μF～0.22μF）between PN, and the wiring of the capacitor should be as short as possible.

备注 10: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 10: The high level of the input signal is effective, and a pull-down resistor is connected to the ground at the input terminals of eachchannel of HVIC; It is suggested to add RC filter circuit at the input terminals to prevent input signal oscillation.

备注 11:所有电容的位置尽可能的靠近 IPM。

Note 11: Position all capacitors as close to IPM as possible.

备注 12:控制地线和电源地线要连接在一个点，走线尽量短；

Note 12: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 13.在短路保护电路，请选择时间常数在 1.5～2us 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 13:In the short−circuit current protection circuit, please select the RF CSC time constant in the range 1.5～2us,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 14./FO,/SD 的连线尽可能短。

Note 14:/FO and /SD must be connected as short as possible.

外形封装图 Detailed Package Outline Drawings

SPE04M60H-AG (DIP26-FP)

单位：mm

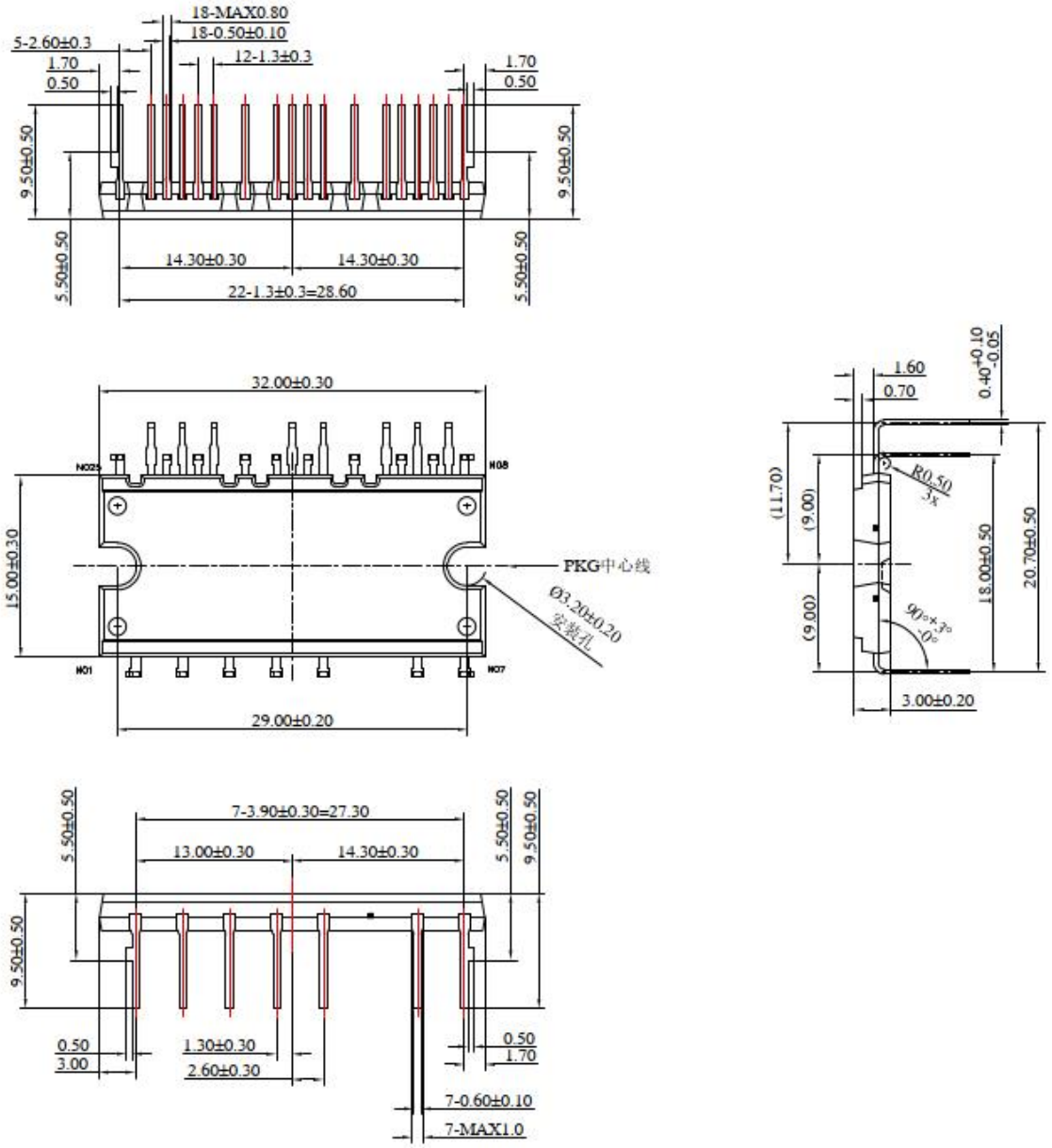


图 11：SPE04M60H-AG 封装外形图

Fig 11：SPE04M60H-A Package Outline Drawings

注意事项

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