



# SPE05S60T-A/C

## 主要参数 MAIN CHARACTERISTICS

|                 |       |
|-----------------|-------|
| 600V/5A 3 相全桥驱动 |       |
| $V_{CES}$       | 600V  |
| $I_C$           | 5A    |
| $V_{ISO}$       | 1500V |

### 用途

- 小功率电机
- 油烟机
- 风扇
- 空气净化器
- 洗碗机水泵

### APPLICATIONS

- Small-power motor
- Lampblack machine
- Electric fan
- Air purifier
- Dishwasher pump

### 产品特性

- 信号高电平有效, 兼容 3.3V 和 5V 的 MCU
- 优化并采用了低电磁干扰设计
- 内置自举二极管
- 内置欠压保护
- 内部集成温度检测输出
- 绝缘耐压 1500V

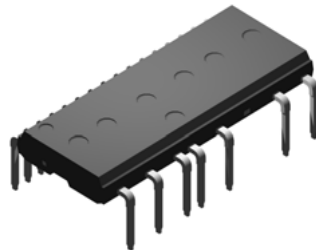
### FEATURES

- Signal high level valid, compatible with 3.3v and 5V MCU
- low EMI design
- Built-in bootstrap diode
- Built-in undervoltage protection
- Internal integrated temperature detection output
- Resistant to high voltage 1500V

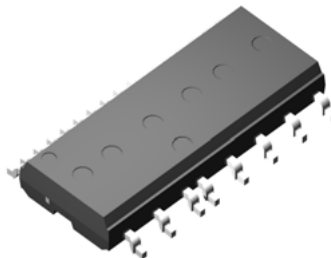
## 订货信息 ORDER MESSAGE

| 订 货 料 号<br>Order number | 产 品 信 息 Product information |                            |                |                |
|-------------------------|-----------------------------|----------------------------|----------------|----------------|
|                         | 无卤-条管<br>Halogen-Free-Tube  | 无卤-编带<br>Halogen-Free-Reel | 印 记<br>Marking | 封 装<br>Package |
| 2A01-0528-16            | SPE05S60T-A                 | N/A                        | SPE05S60T-A    | DIP23-FP       |
| 2A01-0571-16            | SPE05S60T-C                 | N/A                        | SPE05S60T-C    | SOP23-FP       |

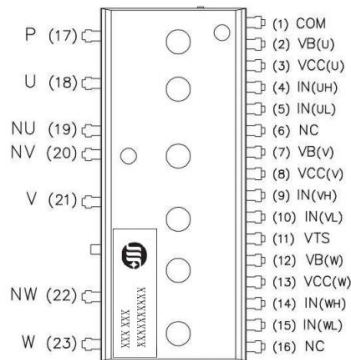
### 封装 Package



DIP23-FP



SOP23-FP



PIN1-PIN23



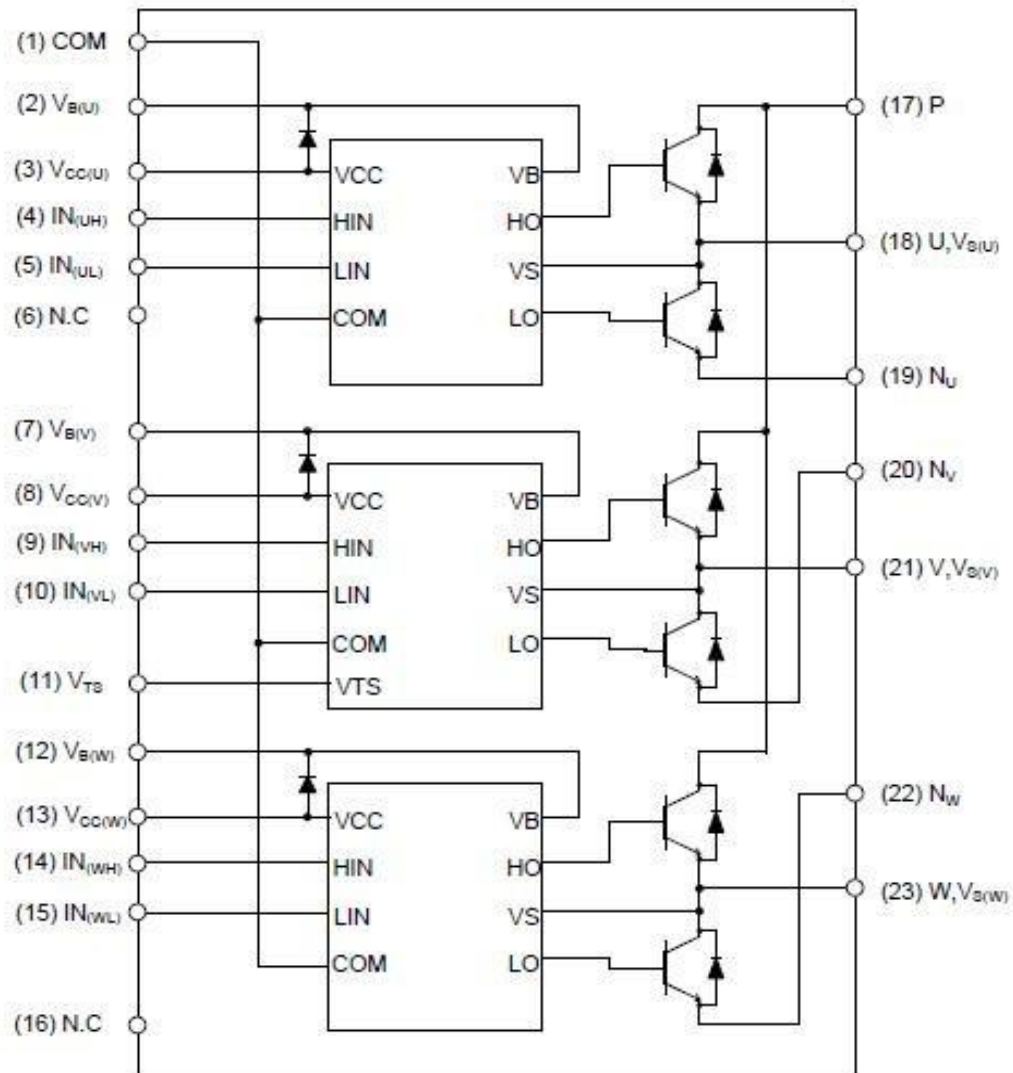


图 1: 模块内部电路示意图

Fig 1: Internal circuit



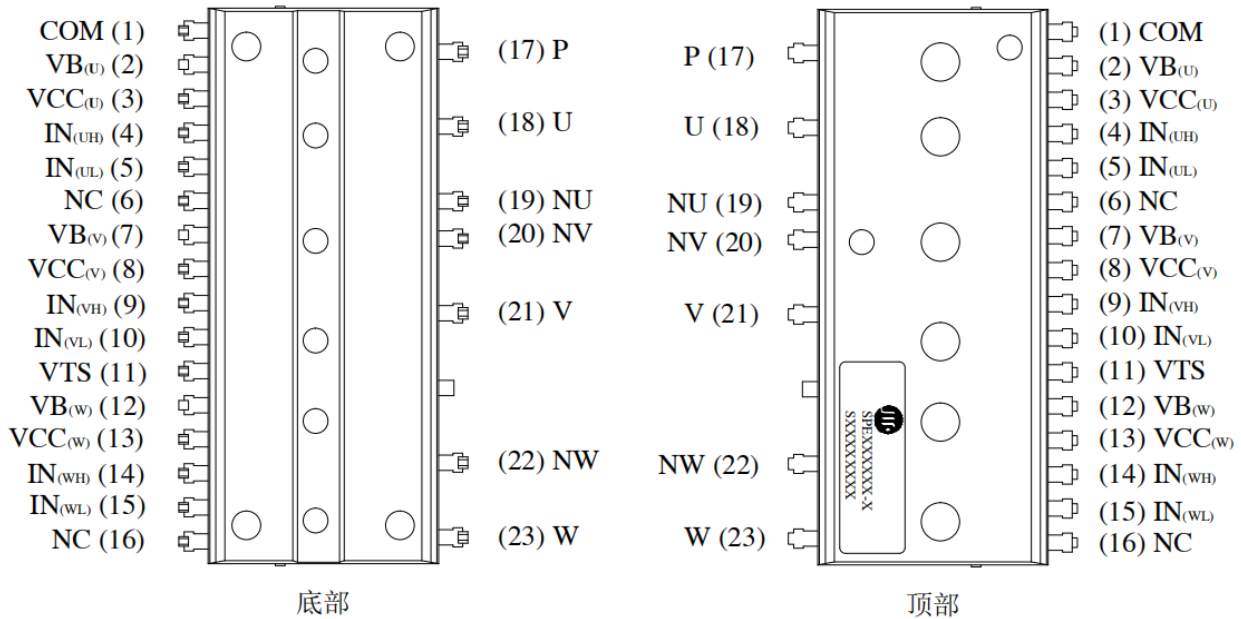


图 2: 模块引脚分布示意图

Fig 2: Distribution of pin

| 引脚编号<br>Number | 引脚名称<br>Name | 引脚描述<br>Description                                                                       |
|----------------|--------------|-------------------------------------------------------------------------------------------|
| 1              | COM          | IC 公共电源接地 IC Common Supply Ground                                                         |
| 2              | VB(U)        | U 相上臂驱动电源端子 Bias Voltage for U-Phase High-Side IGBT Driving                               |
| 3              | VCC(U)       | U 控制电源端子 Bias Voltage for U-Phase IC and Low-Side IGBT Driving                            |
| 4              | IN(UH)       | U 相上臂控制信号输入端子 Signal Input for U-Phase High-Side                                          |
| 5              | IN(UL)       | U 相下臂控制信号输入端子 Signal Input for U-Phase Low-Side                                           |
| 6              | NC           | 无连接 No Connection                                                                         |
| 7              | VB(V)        | V 相上臂驱动电源端子 Bias Voltage for V-Phase High Side IGBT Driving                               |
| 8              | VCC(V)       | V 控制电源端子 Bias Voltage for V-Phase IC and Low Side IGBT Driving                            |
| 9              | IN(VH)       | V 相上臂控制信号输入端子 Signal Input for V-Phase High-Side                                          |
| 10             | IN(VL)       | V 相下臂控制信号输入端子 Signal Input for V-Phase Low-Side                                           |
| 11             | VTs          | HVIC 温度输出 Output for HVIC Temperature Sensing(Just 2A01-0413-16)                          |
| 12             | VB(W)        | W 相上臂驱动电源端子 Bias Voltage for W-Phase High-Side IGBT Driving                               |
| 13             | VCC(W)       | W 控制电源端子 Bias Voltage for W-Phase IC and Low-Side IGBT Driving                            |
| 14             | IN(WH)       | W 相上臂控制信号输入端子 Signal Input for W-Phase High-Side                                          |
| 15             | IN(WL)       | W 相下臂控制信号输入端子 Signal Input for W-Phase Low-Side                                           |
| 16             | NC           | 无连接 No Connection                                                                         |
| 17             | P            | 逆变器直流输入端子 Positive DC-Link Input                                                          |
| 18             | U, VS(U)     | 高端 IGBT 驱动的 U 相偏压接地输出 Output for U-Phase & Bias Voltage Ground for High-Side IGBT Driving |
| 19             | NU           | U 相的直流输入负端 Negative DC-Link Input for U-Phase                                             |
| 20             | NV           | V 相的直流输入负端 Negative DC-Link Input for V-Phase                                             |
| 21             | V, VS(V)     | 高端 IGBT 驱动的 V 相偏压接地输出 Output for V-Phase & Bias Voltage Ground for High-Side IGBT Driving |
| 22             | NW           | W 相的直流输入负端 Negative DC-Link Input for W-Phase                                             |
| 23             | W, VS(W)     | 高端 IGBT 驱动的 W 相偏压接地输出 Output for W Phase & Bias Voltage Ground for High-Side IGBT Driving |

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<br>Symbol    | 参数<br>Parameter                                       | 条件<br>Condition                                                                   | 额定值<br>Ratings | 单位<br>Units      |
|-----------------|-------------------------------------------------------|-----------------------------------------------------------------------------------|----------------|------------------|
| $V_{CC}$        | 电源电压<br>Power supply voltage                          | 应用于 P- NU, NV, NW 之间<br>Applied between P- NU, NV, NW                             | 450            | V                |
| $V_{CC(Surge)}$ | 电源电压 (含浪涌)<br>Power supply voltage (including surge)  | 应用于 P- NU, NV, NW 之间<br>Applied between P- NU, NV, NW                             | 500            | V                |
| $V_{CES}$       | 集电极-发射极之间电压<br>Collector emitter Voltage of Each IGBT | /                                                                                 | 600            | V                |
| $\pm I_C$       | 集电极电流<br>Each IGBT Current, Continuous                | $T_C = 25^\circ\text{C}$ ,                                                        | 5              | A                |
| $\pm I_{CP}$    | 集电极电流 (峰值)<br>Each IGBT Pulse Current, Peak           | $T_C = 25^\circ\text{C}$ , 脉冲宽度小于 1ms<br>$T_C = 25^\circ\text{C}$ , Less than 1mS | 12             | A                |
| $P_C$           | 集电极功耗<br>Maximum Power Dissipation                    | $T_C = 25^\circ\text{C}$ , 单晶片<br>$T_C = 25^\circ\text{C}$ , Each IGBT            | 23             | W                |
| $T_J$           | 结温<br>Junction Temperature                            | (见备注 1)<br>Note1                                                                  | $-40 \sim 150$ | $^\circ\text{C}$ |

## 控制部分 Control Part

| 记号<br>Symbol | 参数<br>Parameter                  | 条件<br>Condition                                      | 额定值<br>Ratings           | 单位<br>Units |
|--------------|----------------------------------|------------------------------------------------------|--------------------------|-------------|
| $V_{CC}$     | 控制电源电压<br>Control Supply Voltage | $V_{CC}$ -COM 之间<br>Applied between $V_{CC}$ and COM | 20                       | V           |
| $V_{BS}$     | 高侧控制电压<br>High-side Bias Voltage | VB-VS 之间<br>Applied between VB and VS                | 20                       | V           |
| $V_{IN}$     | 输入信号电压<br>Input Signal Voltage   | $V_{IN}$ -COM 之间<br>Applied between $V_{IN}$ and COM | $-0.5 \sim V_{CC} + 0.5$ | V           |

## 内部自举电路 Bootstrap Diode Part

| 记号<br>Symbol | 参数<br>Parameter                   | 条件<br>Condition                                                                   | 额定值<br>Ratings | 单位<br>Units |
|--------------|-----------------------------------|-----------------------------------------------------------------------------------|----------------|-------------|
| $V_{RRMB}$   | 反向耐压<br>Control Supply Voltage    | /                                                                                 | 600            | V           |
| $I_{FB}$     | 正向电流<br>High-side Bias Voltage    | $T_C = 25^\circ\text{C}$                                                          | 0.5            | A           |
| $I_{FPB}$    | 正向电流 (峰值)<br>Input Signal Voltage | $T_C = 25^\circ\text{C}$ , 脉冲宽度小于 1mS<br>$T_C = 25^\circ\text{C}$ , Less than 1mS | 1              | A           |





## 整个系统 Total System

| 记号<br>Symbol   | 参数<br>Parameter                                          | 条件<br>Condition                                                                             | 额定值<br>Ratings | 单位<br>Units |
|----------------|----------------------------------------------------------|---------------------------------------------------------------------------------------------|----------------|-------------|
| $V_{PN(Prot)}$ | 自我保护电源电压限制<br>Self-protecting power supply voltage limit | $V_{CC}=V_{DS}=13.5V\sim 16.5V$ , $T_J=125^\circ C$ , 非重复性, $<2\mu s$                       | 400            | V           |
| $T_C$          | 模块壳体工作温度<br>Module shell temperature                     | /                                                                                           | $-20\sim 100$  | $^\circ C$  |
| $T_{STG}$      | 贮存温度<br>Storage Temperature                              | $T_C=25^\circ C$                                                                            | $-40\sim 125$  | $^\circ C$  |
| $V_{ISO}$      | 绝缘耐压<br>Isolation Voltage                                | 60Hz, 正弦, AC 1 分钟, 连接管脚到散热器<br>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  $150^\circ C$  (@表面温度  $T_C \leq 100^\circ C$ )。然而,为了确保 IPM 运行安全,结温应限定于  $T_J(av) \leq 125^\circ C$  (@表面温度  $T_C \leq 100^\circ C$ )。

NOTE 1: The maximum rated junction temperature of the IPM power chip is  $150^\circ C$  (@surface temperature  $T_C \leq 100^\circ C$ ). However, to ensure safe operation of the IPM, the junction temperature should be limited to  $T_J(av) \leq 125^\circ C$  (@surface temperature  $T_C \leq 100^\circ C$ )

## 热阻 Thermal Resistance

| 记号<br>Symbol   | 参数<br>Parameter                                | 条件<br>Condition              | 额定值<br>Ratings | 单位<br>Units  |
|----------------|------------------------------------------------|------------------------------|----------------|--------------|
| $R_{th(j-c)Q}$ | 结到外壳的热阻<br>Junction to Case Thermal resistance | 逆变器工作条件下的单个IGBT<br>Each IGBT | 5.5            | $^\circ C/W$ |
| $R_{th(j-c)F}$ | 结到外壳的热阻<br>Junction to Case Thermal resistance | 逆变器工作条件下的单个FRD<br>Each FRD   | 6.9            | $^\circ C/W$ |

备注 2: 关于壳体温度 ( $T_C$ ) 的测量点, 参见图 6。

Note 2: For the measurement point of shell temperature ( $T_C$ ), see Figure 6.

电气特性 ( $T_J=25^\circ C$ , 除非特殊说明)Electrical Characteristics ( $T_J=25^\circ C$ , Unless Otherwise Specified)

## 逆变部分 Inverter Part

| 记号 Symbol     | 参数<br>Parameter                                      | 条件<br>Condition                             |                                 | 最小值<br>Min. | 典型值<br>Typ. | 最大值<br>Max. | 单位<br>Unit |
|---------------|------------------------------------------------------|---------------------------------------------|---------------------------------|-------------|-------------|-------------|------------|
| $V_{CE(SAT)}$ | 集电极-发射极间饱和电压<br>Collector-emitter saturation voltage | $V_D=V_{DB}=15V$ ,<br>$V_{IN}=5V$           | $I_C=5A$ , $T_J=25^{\circ}C$ ,  | -           | 1.95        | -           | V          |
|               |                                                      |                                             | $I_C=5A$ , $T_J=125^{\circ}C$ , | -           | 2.3         | -           |            |
| $V_{EC}$      | FRD正向电压<br>FRD Forward voltage                       | $V_{IN}=0V$ , $I_C=-5A$ ,                   |                                 | -           | 1.6         | 2.0         | V          |
| $I_{CES}$     | 集电极-发射极间漏电流<br>Collector emitter leakage current     | $V_{CE}=V_{CES}$                            | $T_J=25^{\circ}C$               | -           | -           | 7.5         | $\mu A$    |
|               |                                                      |                                             | $T_J=125^{\circ}C$ ,            | -           | -           | 1           | mA         |
| $t_{ON}$      | 开关时间（备注3）                                            | $V_{PN}=300V$ , $V_D=V_{DB}=15V$ , $I_C=5A$ |                                 | -           | 800         | -           |            |
| $T_C(ON)$     |                                                      |                                             |                                 | -           | 200         | -           |            |





## SPE05S60T-A/C

|              |                            |                                                                                                                                |   |     |     |    |
|--------------|----------------------------|--------------------------------------------------------------------------------------------------------------------------------|---|-----|-----|----|
| $t_{OFF}$    | Switching<br>Times(Note 3) | $V_{IN} = 0\text{ V} \leftrightarrow 5\text{ V}$ , 电感负载 /<br>Inductive Load                                                    | - | 500 | -   | nS |
| $T_{C(OFF)}$ |                            |                                                                                                                                | - | 60  | -   |    |
| $t_{rr}$     |                            |                                                                                                                                | - | 200 | -   |    |
| $E_{on}$     | 开通损耗<br>Turn-on<br>loss    | $I_C = 5\text{ A}$ , $V_{CC} = 400\text{ V}$ , $V_D = V_{DB}$<br>$= 15\text{ V}$ , $L=1\text{ mH}$ , $T_j = 25^\circ\text{ C}$ | - | 42  | 92  | uJ |
| $E_{off}$    | 关断损耗<br>Turn-off<br>loss   |                                                                                                                                | - | 90  | 142 |    |

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。

## 控制部分 Control Part

| 记号<br>Symbol | 参数<br>Parameter                                              | 条件<br>Condition                                                                   |                                                                              | 最小值<br>Min. | 典型值<br>Typ. | 最大值<br>Max. | 单位<br>Unit |
|--------------|--------------------------------------------------------------|-----------------------------------------------------------------------------------|------------------------------------------------------------------------------|-------------|-------------|-------------|------------|
| $I_{QCC}$    | VCC 静态电流<br>Quiescent VCC Supply<br>Current                  | $V_{CC}=15\text{ V}$<br>$V_{IN}=5\text{ V}$                                       | VCC-COM 之间<br>Applied between VCC and COM                                    | -           | 360         | 600         | uA         |
| $I_{QB}$     | VBS 静态电流<br>Quiescent VBS Supply<br>Current                  | $V_{DB}=15\text{ V}$<br>$V_{IN}=5\text{ V}$                                       | VB(U)-U, VB(V)-V, VB(W)-W 之间<br>Applied between VB(U)-U,<br>VB(V)-V, VB(W)-W | -           | 64          | 120         | uA         |
| $UV_{CCD}$   | 低侧欠压保护(图 8)<br>Low-Side Under-Voltage<br>Protection (Fig 8)  | 检测电平<br>VCC Under-Voltage Protection Detection Level                              |                                                                              | 7.2         | 8.2         | 9.2         | V          |
| $UV_{CCR}$   |                                                              | 复位电平<br>VCC Under-Voltage Protection Reset Level                                  |                                                                              | 8.0         | 8.8         | 9.8         | V          |
| $UV_{BSD}$   | 高侧欠压保护(图 9)<br>High-Side Under-Voltage<br>Protection (Fig 9) | 检测电平<br>VBS Under-Voltage Protection Detection Level                              |                                                                              | 7.2         | 8.2         | 9.2         | V          |
| $UV_{BSR}$   |                                                              | 复位电平<br>VBS Under-Voltage Protection Reset Level                                  |                                                                              | 8.0         | 8.8         | 9.8         | V          |
| $V_{TS}$     | HVIC 温度检测输出<br>HVIC Temperature Sensing<br>Voltage Output    | $V_{CC}=15\text{ V}$ , $T_{HVIC}=25^\circ\text{ C}$ (图 5) (Fig5)                  |                                                                              | 0.6         | 0.8         | 1.2         | V          |
| $V_{IH}$     | 输入开启阈值电压<br>ON Threshold Voltage                             | 逻辑高电平, 加在 $V_{IN}$ 与 COM 之间<br>Logic HIGH Level, Applied between $V_{IN}$ and COM |                                                                              | -           | -           | 2.9         | V          |
| $V_{IL}$     | 输入关闭阈值电压<br>OFF Threshold Voltage                            | 逻辑低电平, 加在 $V_{IN}$ 与 COM 之间<br>Logic Low Level, Applied between $V_{IN}$ and COM  |                                                                              | 0.8         | -           | -           | V          |

## 自举二极管部分

| 记号<br>Symbol | 参数<br>Parameter                    | 条件<br>Condition                                     | 最小值<br>Min. | 典型值<br>Typ. | 最大值<br>Max. | 单位<br>Unit |
|--------------|------------------------------------|-----------------------------------------------------|-------------|-------------|-------------|------------|
| $V_{FB}$     | 正向电压<br>Forward voltage            | $I_F = 0.1\text{ A}$ , $T_C = 25^\circ\text{ C}$    | -           | 4.5         | -           | V          |
| $t_{rrB}$    | 反向恢复时间<br>Reverse recovery<br>time | $I_F = 0.1\text{ A}$ ,<br>$T_C = 25^\circ\text{ C}$ | -           | 80          | -           | ns         |





## 推荐工作条件 Recommended Operating Conditions

| 记号<br>Symbol                   | 参数<br>Parameter                                       | 条件<br>Condition                                                             | 最小值<br>Min. | 典型值<br>Typ. | 最大值<br>Max. | 单位<br>Unit |
|--------------------------------|-------------------------------------------------------|-----------------------------------------------------------------------------|-------------|-------------|-------------|------------|
| $V_{PN}$                       | 电源电压<br>Supply Voltage                                | 施加在P和N之间<br>Between P and N                                                 | -           | 300         | 400         | V          |
| $V_{CC}$                       | 控制电源电压<br>Control Supply Voltage                      | 施加在 $V_{CC}$ 和 COM之间<br>Between $V_{CC}$ and COM                            | 13.5        | 15.0        | 16.5        | V          |
| $V_{BS}$                       | 高端偏压<br>High-Side Bias Voltage                        | 施加在 $V_B$ 和 $V_S$ 之间<br>Between $V_B$ and $V_S$                             | 13.5        | 15.0        | 16.5        | V          |
| $dV_{CC}/dt$ ,<br>$dV_{BS}/dt$ | 控制电源波动<br>Control power fluctuation                   |                                                                             | -1          | -           | 1           | V/us       |
| $V_{IN(ON)}$                   | 输入导通阈值电压<br>Input ON Threshold Voltage                | 施加在 $V_{IN}$ 和COM之间<br>Between $V_{IN}$ and COM                             | 2.8         | -           | $V_{CC}$    | V          |
| $V_{IN(OFF)}$                  | 输入关断阈值电压<br>Input OFF Threshold Voltage               |                                                                             | 0           | -           | 0.6         | V          |
| $t_{dead}$                     | 防止桥臂直通的死区时间<br>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<br>PWM Switching Frequency                   | $T_j \leq 150^\circ\text{C}$                                                | -           | -           | 20          | KHz        |
| COM                            | COM 电压波动<br>COM voltage fluctuation                   | COM 和 NU, NV, NW 之间 (包括浪涌)<br>Between COM and NU, NV, NW                    | -5          | -           | +5          | V          |



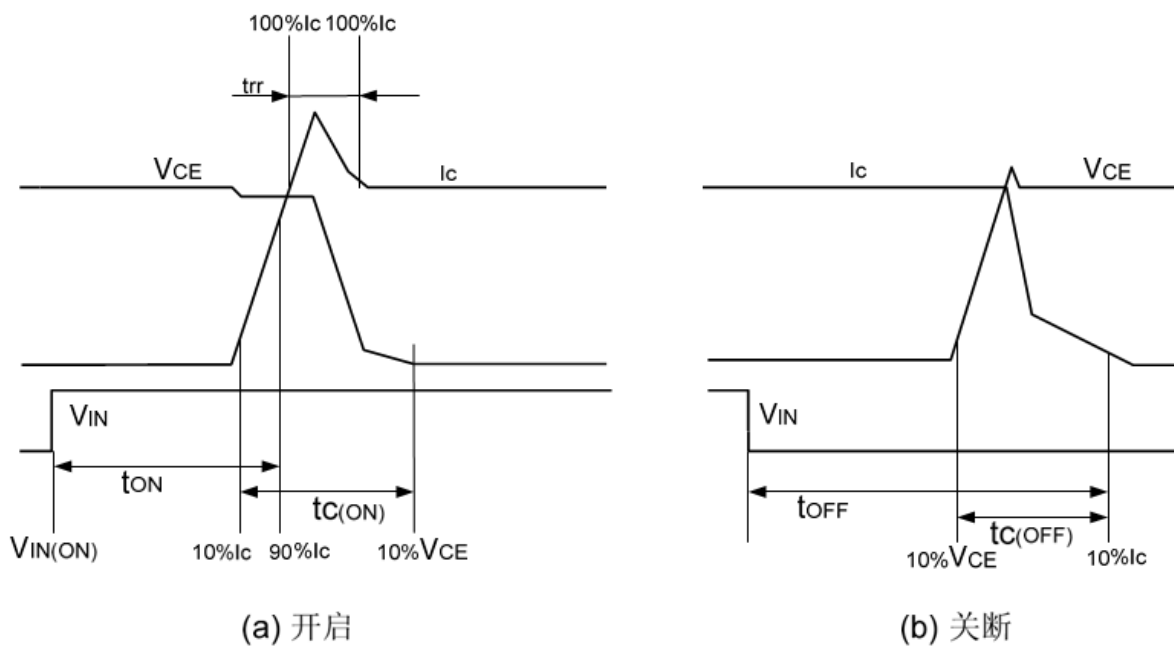


图 4: 开关时间定义

Fig 4: Switching Time Definition

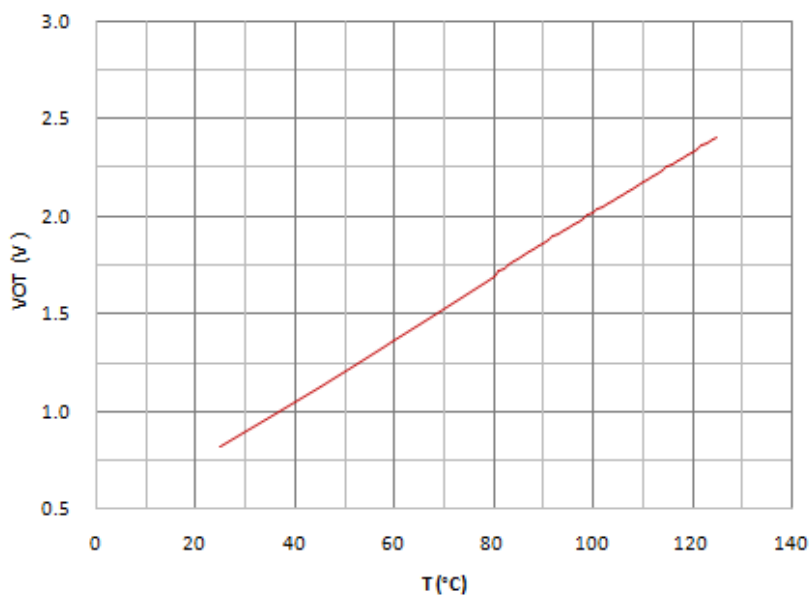


图 5: HVIC 温度检测输出温度—电压曲线

Fig 5: Curves of HVIC Temperature detection-voltage curve



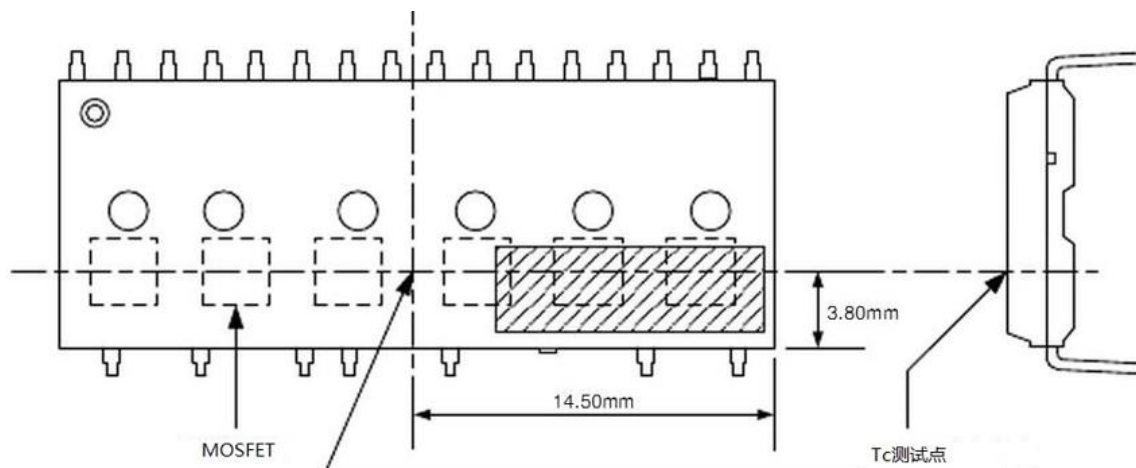


图 6: 壳温 Tc 测试点  
Fig 6: Case Temperature Measurement

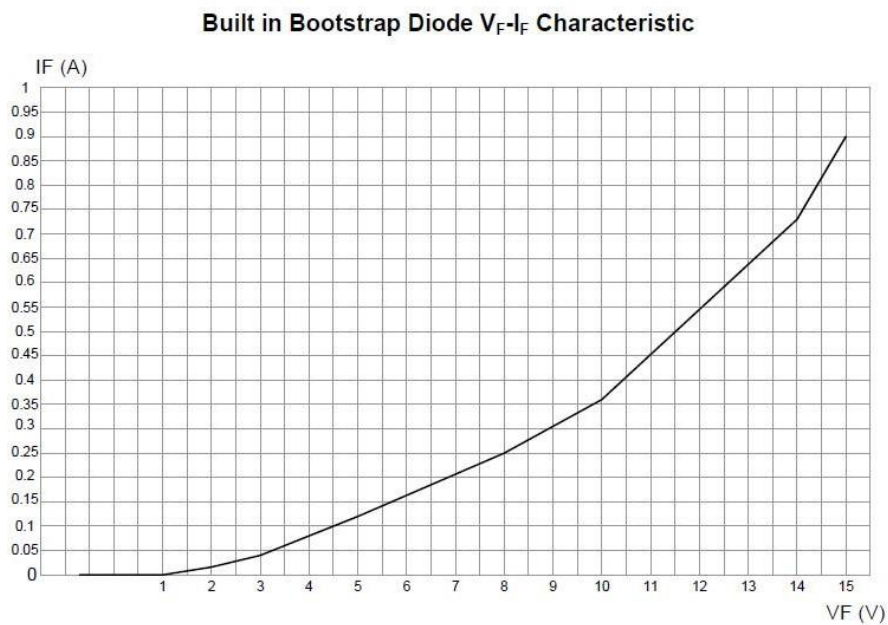


图 7. 内置自举二极管特性 (典型值)  
Fig 7: Built-in bootstrap diode characteristics (typical values)

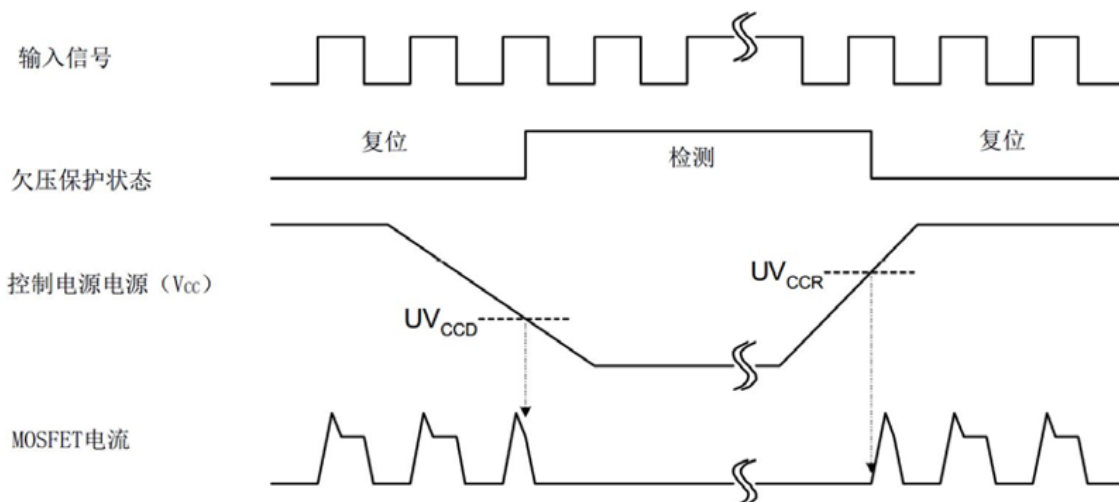


图 8: 欠压保护时序图(低侧)

Fig 8: Undervoltage protection sequence diagram (low side)

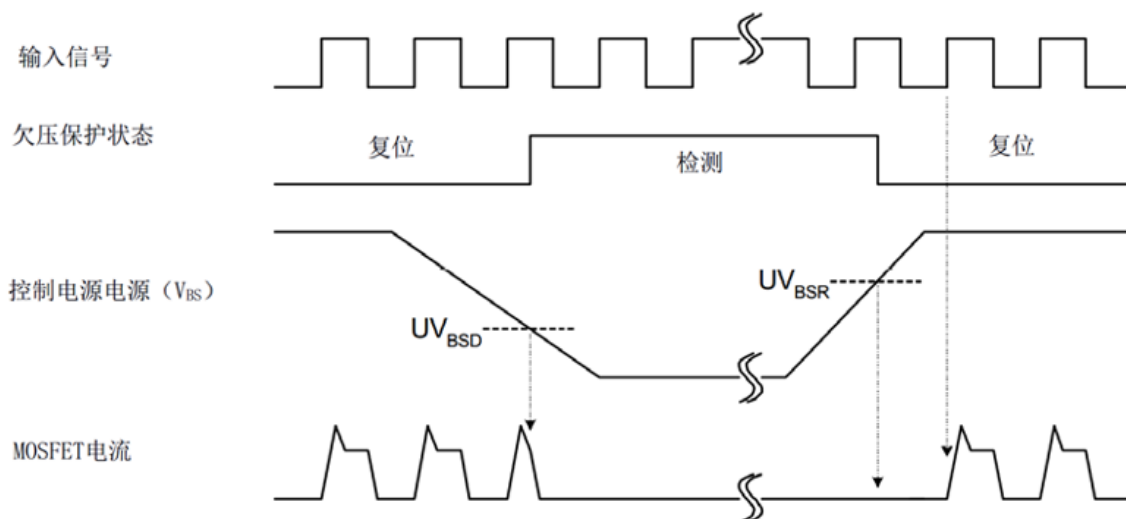


图 9: 欠压保护时序图(高侧)

Fig 9: Undervoltage protection sequence diagram (High side)



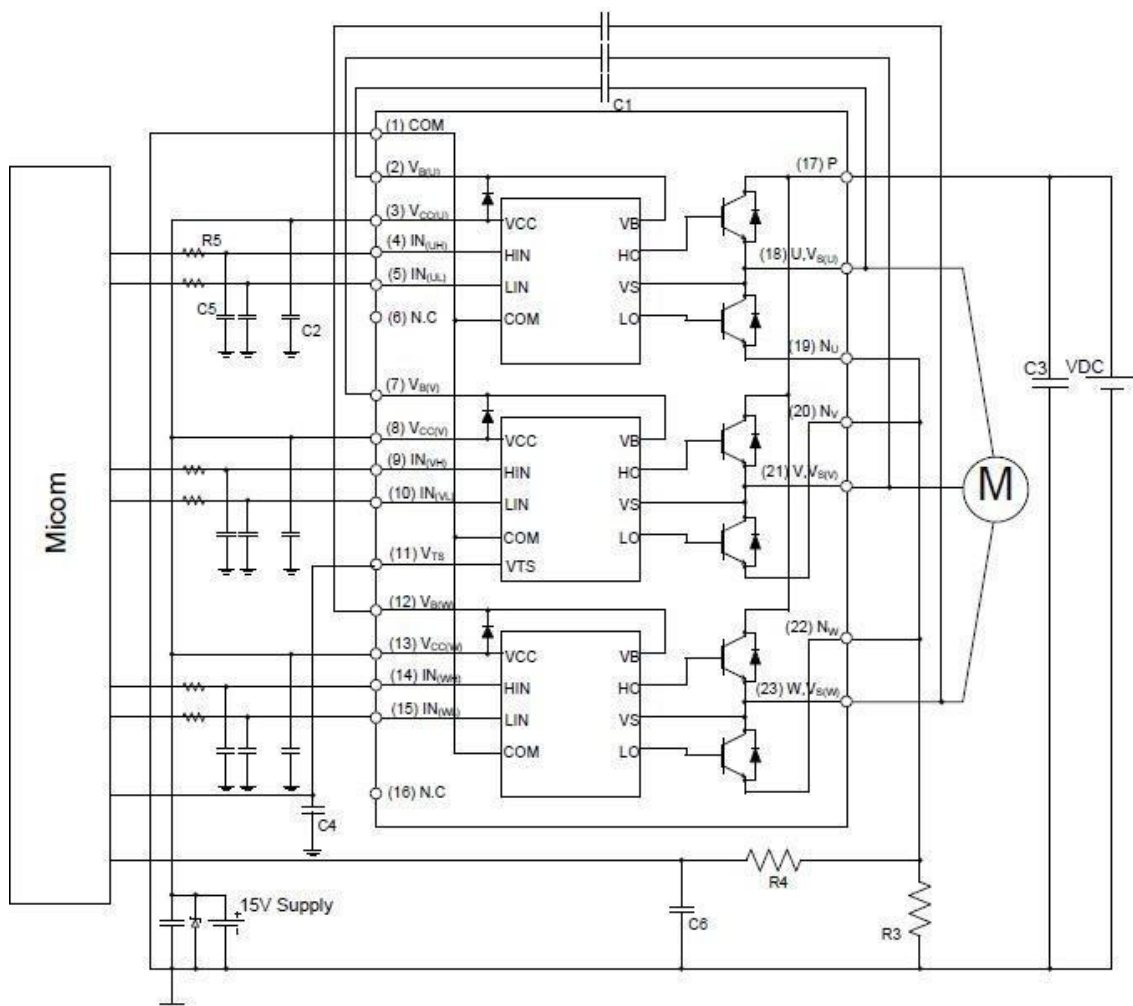


图 10: 典型应用电路图

Fig 10: Example of Application Circuit

## 注/Note:

备注 4: 关于引脚的位置请参阅图 1.

NOTE 4: Refer to figure 1 for pin location.

备注 5: IPM 产品和 MCU 的每个输入端的 RC 耦合 (R5 和 C5, R4 和 C6) 和 C4, 能有效地防止由浪涌噪声产生的错误的输入信号。

NOTE 5: The RC coupling (R5 and C5, R4 and C6) and C4 of each input terminal of IPM product and MCU can effectively prevent the wrong input signal generated by surge noise.

备注 6: 由于位于 COM 和低端 IGBT 的源极端子之间, R3 的压降会影响低端的开关性能和自举特性。为此稳态情况下的 R3 的压降应小于 1V。

NOTE 6: Because it is located between COM and the source terminal of low-end IGBT, the voltage drop of R3 will affect the switching performance and bootstrap characteristics of low-end. For this reason, the pressure drop of R3 under steady-state conditions should be less than 1V.

备注 7: 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。





NOTE 7: in order to avoid surge voltage and HVIC failure, the wiring between the grounding wire and the output terminal should be short and thick.

备注 8: 所有的滤波电容器应紧密连接到 IPM 产品, 他们应当具有能够很好的阻挡高频纹波电流的特性。

NOTE 8: All filter capacitors shall be closely connected to IPM products, and they shall have the characteristics of good blocking high-frequency ripple current.





### SPE05S60T-A (DIP23-FP)

单位: mm

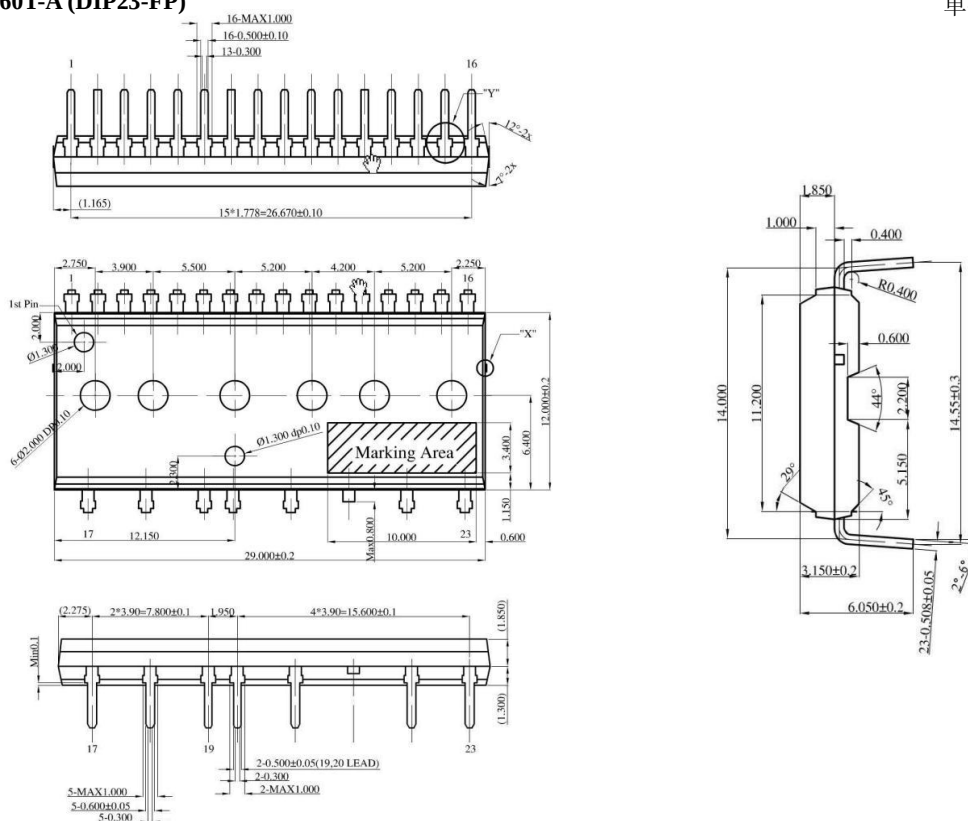


图 11: SPE05S60T-A 封装外形图

**Fig11: SPE05S60T-A Package Outline Drawings**

**SPE05S60T-C(SOP23-FP)**

单位: mm

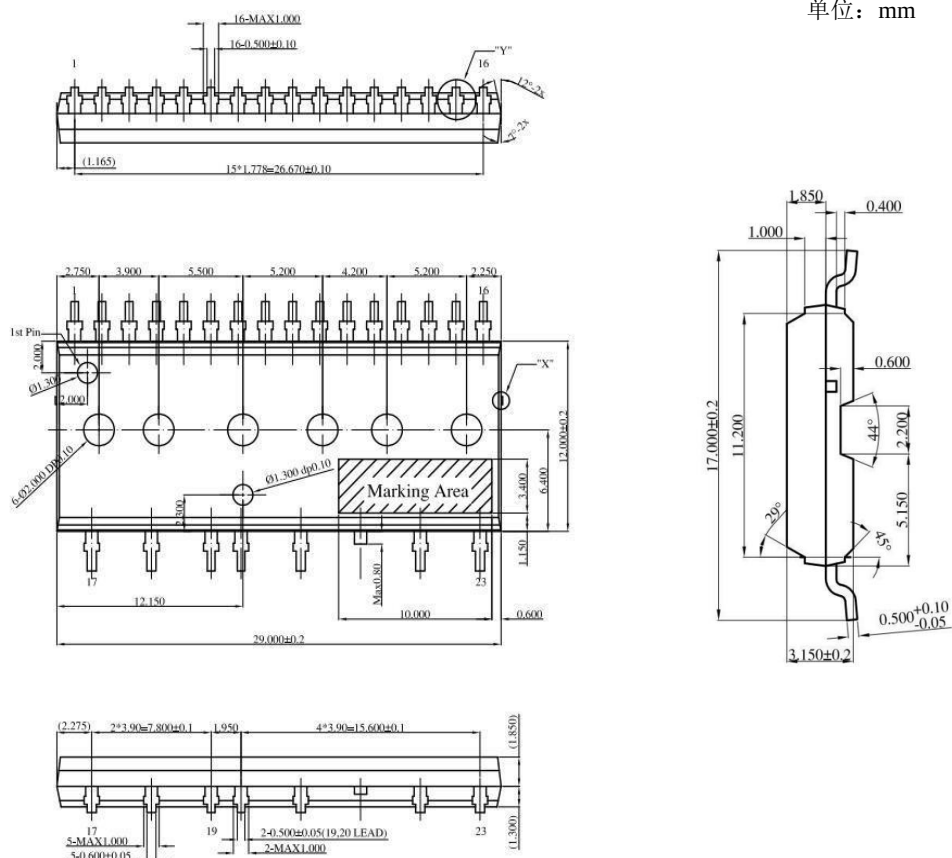


图 12: SPE05S60T-C 封装外形图

Fig 12: SPE05S60T-C Package Outline Drawings



### 注意事项

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