BYD 比亚迪半导体 Semiconductor

# BIP120035V

## 概述

BIP120035V是最新设计开发的1200V/35A大封装智能功率模块（IPM-Intelligent Power Module）。该产品有功耗小、抗干扰能力强等优点。与绝缘栅双极型晶体管（IGBT）相匹配，内部集成了欠压闭锁电路、温度模拟输出功能、过流保护电路和IGBT驱动电路，进一步丰富了模块功能，提高了系统的可靠性和稳定性。采用了分立的负端子，可使外围电路独立监测逆变器的每一相电流，使用更灵活。

## General Description

BIP120035V is an advanced intelligent power module that BYD has newly developed and designed to provide very compact and high performance ac motor drivers，mainly targeting AC 400V class motor control applications. It combines optimized circuit protection and drive matched to low-loss IGBT System reliability is further enhanced by the integrated under-voltage lock-out，analog output of LVIC temperature and short-circuit protection. The high speed built-in HVIC provides optocoupler less single-supply IGBT gate driving capability that further reduce the overall size of the inverter system design. Each phase current of inverter can be monitored separately due to the divided negative dc terminals

## 产品特性

- 1200V/35A 三相全桥逆变器
- 内置 LVIC、HVIC，具有欠压、过流保护
- 分立的三相直流负端，可独立检测线电流
- 内置具有电流传感功能的双发射极 IGBT
- 温度模拟输出功能
- 绝缘等级为 2500$V_{RMS}$/min

.

## Features

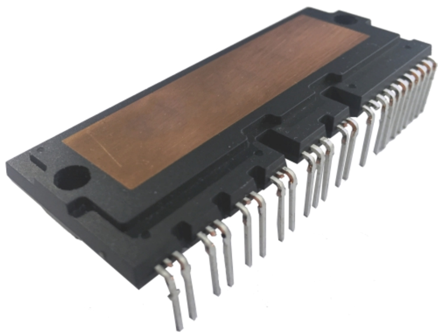
- 1200V-35A 3-phase IGBT inverter bridge
- Divided negative dc-link terminals for inverter current sensing applications
- Under-voltage lock-out protection.
- Adjustable Over-current Protection via integrated Sense-IGBTs.
- Analog output of LVIC temperature
- Isolation rating of 2500Vrms/1min

## 应用领域

- 商用空调、新能源汽车空调
- AC400V 级电机控制，如伺服、变频器

## Applications

- commercial conditioner, new energy auto AC controller
- AC 400V class motor control， Such as commercial conditioner， general-purpose inverter, servo.



## 封装/Package

DIP30-7931

## 内部等效电路和输入输出引脚及引脚布局

# Internal Equivalent Circuit , Input/Output Pins and Pin Configuration

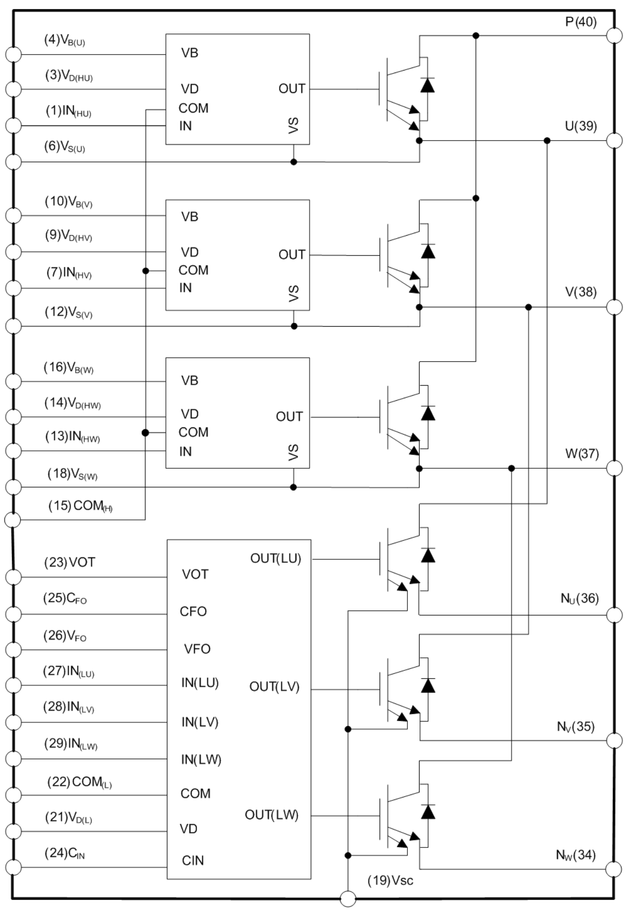



图1. 内部结构框图
**Fig 1.Internal Block Diagram**

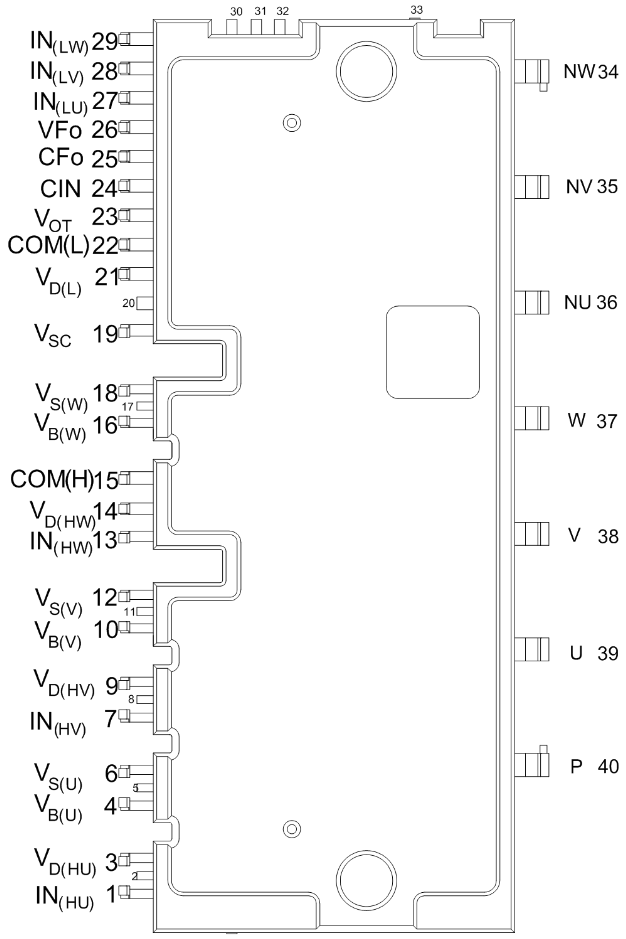



图2. 引脚布局图正视图
**Fig 2. Pin Configuration（Top View）**

## 引脚描述/Pin Descriptions

| 引脚号<br>**Pin** | 引脚名<br>**Name** | 描述<br>**Descriptions** |
|---|---|---|
| 1 | $IN_{(HU)}$ | 高端U相驱动信号输入端<br>Signal Input for High-side U Phase |
| 2 | N.C | 无连接<br>No Connect |
| 3 | $V_{D(HU)}$ | 高端U相驱动电源端<br>High-Side Bias Voltage for U Phase IC |
| 4 | $V_{B(U)}$ | 高端U相驱动辅助电源正端<br>High-side Bias Voltage for U Phase IGBT Driving |
| 5 | $OUT_{(HU)}$ | 高端U相驱动信号输出端<br>Signal output for High-side U Phase |
| 6 | $V_{S(U)}$ | 高端U相驱动辅助电源负端<br>High-side Bias Voltage Ground for U Phase IGBT Driving |

| | | |
|---|---|---|
| 7 | $IN_{(HV)}$ | 高端V相驱动信号输入端<br>Signal Input for High-side V Phase |
| 8 | N.C | 无连接<br>No Connect |
| 9 | $V_{D(HV)}$ | 高端V相驱动电源端<br>High-side Bias Voltage for V Phase IC |
| 10 | $V_{B(V)}$ | 高端V相驱动辅助电源正端<br>High-side Bias Voltage for V Phase IGBT Driving |
| 11 | $OUT_{(HV)}$ | 高端V相驱动信号输出端<br>Signal output for High-side V Phase |
| 12 | $V_{S(V)}$ | 高端V相驱动辅助电源负端<br>High-side Bias Voltage Ground for V Phase IGBT Driving |
| 13 | $IN_{(HW)}$ | 高端W相驱动信号输入端<br>Signal Input for High-side W Phase |
| 14 | $V_{D(HW)}$ | 高端W相驱动电源端<br>High-side Bias Voltage for W Phase IC |
| 15 | $COM_{(H)}$ | 高端驱动电源地<br>High-side Common Supply Ground |
| 16 | $V_{B(W)}$ | 高端W相驱动辅助电源正端<br>High-side Bias Voltage for W Phase IGBT Driving |
| 17 | $OUT_{(HW)}$ | 高端W相驱动信号输出端<br>Signal output for High-side W Phase |
| 18 | $V_{S(W)}$ | 高端W相驱动辅助电源负端<br>High-side Bias Voltage Ground for W Phase IGBT Driving |
| 19 | $V_{SC}$ | 传感电流检测端<br>Resistor for Short-Circuit Current Detection |
| 20 | $OUT_{(LU)}$ | 低端U相驱动信号输出端<br>Signal output for Low-side U Phase |
| 21 | $V_{D(L)}$ | 低端驱动电源端<br>L Low-Side Bias Voltage for IC and IGBTs Driving |
| 22 | $COM_{(L)}$ | 低端驱动电源地<br>Low-Side Common Supply Ground |
| 23 | $V_{OT}$ | 温度模拟输出端<br>Temperature Output |
| 24 | $C_{IN}$ | 短路触发电压检测端<br>Capacitor (Low-pass Filter) for Short-Current Detection Input |
| 25 | $C_{FO}$ | 故障输出脉冲宽度设定端<br>Capacitor for Fault Output Duration Selection |
| 26 | $V_{FO}$ | 故障信号输出端<br>Fault Output |
| 27 | $IN_{(LU)}$ | 低端U相驱动信号输入端<br>Signal Input for Low-side U Phase |
| 28 | $IN_{(LV)}$ | 低端V相驱动信号输入端<br>Signal Input for Low-side V Phase |
| 29 | $IN_{(LW)}$ | 低端W相驱动信号输入端<br>Signal Input for Low-side W Phase |
| 30 | N.C | 无连接<br>No Connect |
| 31 | $OUT_{(LW)}$ | 低端W相驱动信号输出端<br>Signal output for Low-side W Phase |

| | | |
|---|---|---|
| 32 | $OUT_{(LV)}$ | 低端V相驱动信号输出端<br>Signal output for Low-side V Phase |
| 33 | N.C | 无连接<br>No Connect |
| 34 | $N_W$ | W相直流负端<br>Negative DC–Link Input for W Phase |
| 35 | $N_V$ | V相直流负端<br>Negative DC–Link Input for V Phase |
| 36 | $N_U$ | U相直流负端<br>Negative DC–Link Input for U Phase |
| 37 | W | W相输出端<br>Output for W Phase |
| 38 | V | V相输出端<br>Output for V Phase |
| 39 | U | U相输出端<br>Output for U Phase |
| 40 | P | 直流正端<br>Positive DC–Link Input |

## 最大绝对额定值(Tj=25°C, 除非另外注明)

## Absolute Maximum Ratings ($T_J$ = 25°C, unless otherwise noted)

### 逆变器部分/Inverter Part

| 符号<br>**Symbol** | 参数<br>**Parameter** | 工作条件<br>**Conditions** | 额定值<br>**Ratings** | 单位<br>**Units** |
|---|---|---|---|---|
| $V_{PN}$ | 电源电压<br>Supply voltage | P-$N_U$, $N_V$, $N_W$之间<br>Applied between P-$N_U$, $N_V$, $N_W$ | 900 | V |
| $V_{PN}$(surge) | 电源（浪涌）<br>Supply voltage (surge) | P-$N_U$, $N_V$, $N_W$之间<br>Applied between P-$N_U$, $N_V$, $N_W$ | 1000 | V |
| $V_{CES}$ | 集电极-发射极之间电压<br>Collector-emitter voltage | $V_{GE}$=0V,$I_C$=100uA,$T_J$=25°C | 1200 | V |
| $\pm I_C$ | 单只IGBT集电极电流<br>Each IGBT collector current | $T_C$ = 25°C | 35 | A |
| $\pm I_{CP}$ | 单只IGBT集电极电流（峰值）<br>Each IGBT collector current (peak) | $T_C$ = 25°C，持续1ms的脉冲宽度<br>$T_C$ = 25°C , less than 1ms | 70 | A |
| $P_C$ | 集电极功耗<br>Collector dissipation | $T_C$ = 25°C，每一片<br>$T_C$ = 25°C, per 1 chip | 129.9 | W |
| $T_J$ | 结温<br>Junction temperature | (注1)<br>(**Note 1**) | -40~+150 | °C |

**注 1**：智能功率模块中集成的功率芯片的最大结温额定值为 150°C(@TC ≤ 100°C)。但是，为了确保智能功率模块的安全工作，平均结温应限制为TJ(avg) ≤ 125°C(@TC ≤100°C)。

**Note 1 :** The maximum junction temperature rating of the power chips integrated within the IPM is 150°C (@ $T_C$ ≤ 100°C). However, to ensure safe operation of the IPM, the average junction temperature should be limited to $T_J$ (avg) ≤ 125°C (@ $T_C$ ≤ 100°C).

## 控制部分/Control Part

| 符号<br>Symbol | 参数<br>Parameter | 工作条件<br>Conditions | 额定值<br>Ratings | 单位<br>Units |
| --- | --- | --- | --- | --- |
| $V_D$ | 控制电源电压<br>Control supply voltage | $V_{D(L)}$ -$COM_{(L)}$,$V_{D(HU)}$, $V_{D(HV)}$, $V_{D(HW)}$-$COM_{(H)}$之间<br>Applied between $V_{D(L)}$–$COM_{(L)}$, $V_{D(HU)}$,$V_{D(HV)}$,$V_{D(HW)}$ -$COM_{(H)}$ | 20 | V |
| $V_{DB}$ | 控制电源电压<br>Control supply voltage | $V_{B(U)}$-$V_{S(U)}$, $V_{B(V)}$-$V_{S(V)}$,$V_{B(W)}$-$V_{S(W)}$之间<br>Applied between $V_{B(U)}$-$V_{S(U)}$, $V_{B(V)}$-$V_{S(V)}$, $V_{B(W)}$ -$V_{S(W)}$ | 20 | V |
| $V_{IN}$ | 输入信号电压<br>Input Signal voltage | $IN_{(LU)}$,$IN_{(LV)}$,$IN_{(LW)}$-$COM_{(L)}$, $IN_{(HU)}$,$IN_{(HV)}$,$IN_{(HW)}$-$COM_{(H)}$之间<br>Applied between $IN_{(LU)}$,$IN_{(LV)}$,$IN_{(LW)}$-$COM_{(L)}$, $IN_{(HU)}$, $IN_{(HV)}$, $IN_{(HW)}$-$COM_{(H)}$, | -0.3~ $V_D$+0.3 | V |
| $V_{FO}$ | 故障输出电压<br>Fault output supply voltage | $V_{FO}$-$COM_{(L)}$之间<br>Applied between $V_{FO}$-COM | -0.3~$V_D$+0.3 | V |
| $I_{FO}$ | 故障输出电流<br>Fault output current | $V_{FO}$ 处灌电流<br>Sink current at $V_{FO}$ terminal | 2.0 | mA |
| $V_{CIN}$ | 电流检测输入电压<br>Current sensing input voltage | $C_{IN}$-$COM_{(L)}$之间<br>Applied between $C_{IN}$-COM | -0.3~$V_D$+0.3 | V |

## 整个系统/Total System

| 符号<br>Symbol | 参数<br>Parameter | 工作条件<br>Conditions | 额定值<br>Ratings | 单位<br>Units |
| --- | --- | --- | --- | --- |
| $V_{PN(PROT)}$ | 自保护电源电压限制（短路保护能力）<br>Self protection supply voltage limit (short circuit protection capability) | $V_D$ = 13.5~16.5V, $T_J$ = 125°C, 非重复性，小于 2us<br>$V_D$ = 13.5~16.5V, Inverter part $T_J$ = 125°C,non-repetitive,less than 2us | 800 | V |
| $T_C$ | 工作壳温<br>Module Case Operation Temperature | | -20~+100 | °C |
| $T_{STG}$ | 存储/ 保存温度<br>Storage temperature | | -40~+150 | °C |
| $V_{ISO}$ | 绝缘电压<br>Isolation voltage | 正弦波形 60Hz,，交流 1 分钟，所有端子短路后与散热器之间<br>60Hz, Sinusoidal, AC 1 minute, connecting pins to DBC | 2500 | Vrms |

### 热阻/Thermal Resistance

| 符号<br>Symbol | 参数<br>Parameter | 工作条件<br>Conditions | 最小值<br>Min. | 典型值<br>Typ. | 最大值<br>Max. | 单位<br>Units |
|---|---|---|---|---|---|---|
| $R_{th(j-c)Q}$ | 结点-壳体的热阻<br>Junction to case thermal resistance | 逆变器 IGBT 部分（每 1/6 模块）Inverter IGBT part (per 1/6 module) | - | - | 0.77 | °C/W |
| $R_{th(j-c)F}$ | | 逆变器 FRD 部分（每 1/6 模块）Inverter FRD part (per 1/6 module) | - | - | 1.25 | °C/W |

## 电气特性/ Electrical Characteristics

($T_J$ =25°C,除非另有说明/unless otherwise noted)

### 逆变器部分/Inverter Part

| 符号<br>Symbol | | 参数<br>Parameter | 工作条件<br>Conditions | | 最小值<br>Min. | 典型值<br>Typ. | 最大值<br>Max. | 单位<br>Units |
|---|---|---|---|---|---|---|---|---|
| $V_{CE(SAT)}$ | | 集电极-发射极间饱和电压<br>Collector-Emitter Saturation Voltage | $V_D$=$V_{BS}$=15V, $V_{IN}$=5V,$I_C$=35 A, | $T_J$ =25°C | --- | 2.2 | 2.6 | V |
| | | | | $T_J$ =125°C | --- | 2.3 | 2.7 | |
| $V_F$ | | FRD Forward Voltage | $V_{IN}$=0V , $I_C$=35A, $T_J$ =25°C | | --- | 1.9 | 2.4 | |
| HS | ton | 开关时间<br>Switching Times | $V_{PN}$=600V, $V_D$=$V_{BS}$=15V<br>$I_C$ = 35A, $V_{IN}$ = 0 ↔ 5V<br>$T_J$=25°C,<br>感性负载（注 **2**）<br>Inductive Load(**Note 2**) | | --- | 1100 | --- | ns |
| | tc(on) | | | | --- | 100 | --- | |
| | $t_{rr}$ | | | | --- | 75 | --- | |
| | toff | | | | --- | 1400 | --- | |
| | tc(off) | | | | --- | 140 | --- | |
| LS | ton | | | | --- | 660 | --- | |
| | tc(on) | | | | --- | 220 | --- | |
| | $t_{rr}$ | | | | --- | 200 | --- | |
| | toff | | | | --- | 1000 | --- | |
| | tc(off) | | | | --- | 150 | --- | |
| $I_{CES}$ | | 集电极-发射极间漏电流<br>Collector-Emitter Leakage Current | $V_{CE}$=$V_{CES}$,$V_{GE}$ =0V, | $T_J$ =25°C | --- | --- | 0.1 | mA |
| | | | | $T_J$ =125°C | --- | --- | 1.0 | |

注 2: $t_{ON}$ 和$t_{OFF}$ 包括模块内部驱动集成电路(IC) 的传输延迟时间。 $t_{C(ON)}$ 和$t_{C(OFF)}$ 指在内部给定的门极驱动条件下，IGBT 本身的切换时间，$t_{rr}$ 指FRD反向恢复时间。详细信息，参考图3。

**Note 2 :** ton and toff include the propagation delay time of the internal drive IC. tc(on) and tc(off) are the switching time of IGBT itself under the given gate driving condition internally, $t_{rr}$ is the reverse recovery time.See figure 3.

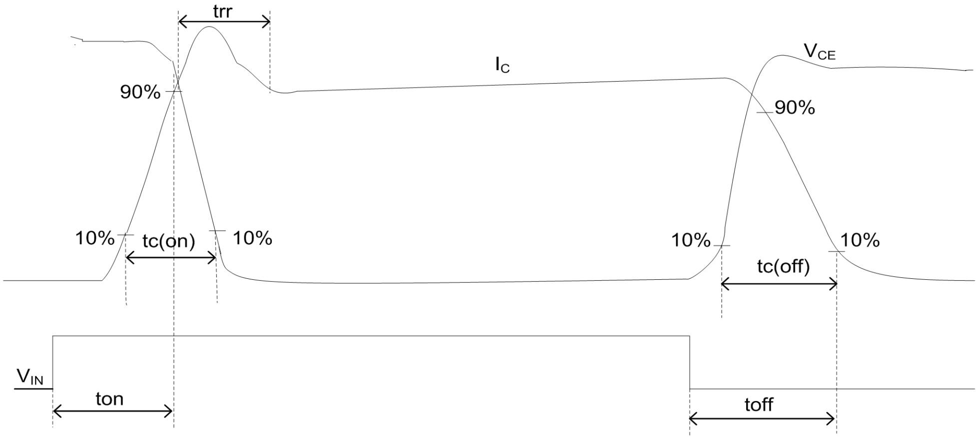



**图 3. 开关时间定义**
**Fig 3. Switching Time Definition**

## 控制部分/Control Part

| 符号 Symbol | 项目 Parameter | 工作条件 Conditions | | 最小值 Min. | 典型值 Typ. | 最大值 Max. | 单位 Units |
|---|---|---|---|---|---|---|---|
| $I_{QDH}$ | $V_D$静态电流 Quiescent $V_D$ Supply Current | $V_{D(HU,HV,HW)}$=15V, IN(HU,HV,HW) =0V | $V_{D(HU)}$,$V_{D(HV)}$, $V_{D(HW)}$ -COM(H) | --- | --- | 340 | μA |
| | | $V_{D(HU,HV,HW)}$=15V, IN(HU,HV,HW) =5V | | | | 340 | |
| $I_{QDL}$ | | $V_{DL}$=15V, IN(LU,LV,LW) =0V | $V_{D(L)}$-COM(L) | --- | --- | 1.0 | mA |
| | | $V_{DL}$=15V, IN(LU,LV,LW) =5V | | | | 1.0 | |
| $I_{QBS}$ | $V_{BS}$静态电流 Quiescent $V_{BS}$ Supply Current | $V_{BS}$=15V, IN(HU,HV,HW)=0V | $V_{B(U)}$-$V_{S(U)}$,$V_{B(V)}$-$V_{S(V)}$,$V_{B(W)}$-$V_{S(W)}$ | --- | --- | 230 | μA |
| | | $V_{BS}$=15V, IN(HU,HV,HW)=5V | | --- | --- | 230 | |
| $V_{FOH}$ | 故障输出电压 Fault Output Voltage | $V_{CIN}$ =0V, $V_{FO}$电路:4.7K 上拉到 5V<br>$V_{CIN}$=0V,$V_{FO}$ Circuit:4.7K to 5V Pull-up | | 4.5 | --- | --- | V |
| $V_{FOL}$ | | $V_{CIN}$ =1V, $V_{FO}$电路:4.7K 上拉到 5V<br>$V_{CIN}$=1V,$V_{FO}$ Circuit:4.7K to 5V Pull-up | | --- | --- | 0.8 | |
| $V_{CIN(ref)}$ | 短路保护触发电压 Short Circuit Trip Level | $V_{DL}$=15V (注 3/**Note 3**) | $V_{CIN}$-COM(L) | 0.9 | 1.0 | 1.1 | V |
| $UV_{DLD}$ | 电源欠压保护 Supply Circuit Under-Voltage Protection | 检测电平 Detection Level | | 11 | 12 | 13 | V |
| $UV_{DLR}$ | | 复位电平 Rest Level | | 12 | 13 | 14 | |
| $UV_{BSD}$ | | 检测电平 Detection Level | | 7.9 | 9.3 | 10.7 | |
| $UV_{BSR}$ | | 复位电平 Rest Level | | 8.7 | 10.2 | 11.7 | |
| $V_{OT}$ | 温度模拟输出电压 Temperature Output | LVIC 温度=110℃（**注 4**）<br>LVIC temperature=110℃（**Note 4**） | | 3.12 | 3.20 | 3.28 | V |

| | | | | | | |
|---|---|---|---|---|---|---|
| $t_{FO}$ | 故障输出脉冲宽度<br>Fault-out Pulse Width | $C_{FO}$=33nF（注 **5/Note 5**） | --- | 2.30 | --- | ms |
| $V_{IN(ON)}$ | 导通阈值电压<br>ON Threshold Voltage | $IN_{(LU)}$,$IN_{(LV)}$,$IN_{(LW)}$-$COM_{(L)}$,<br>$IN_{(HU)}$,$IN_{(HV)}$,$IN_{(HW)}$-$COM_{(H)}$之间<br>Applied between<br>$IN_{(LU)}$,$IN_{(LV)}$,$IN_{(LW)}$-$COM_{(L)}$,<br>$IN_{(HU)}$, $IN_{(HV)}$, $IN_{(HW)}$ -$COM_{(H)}$ | --- | --- | 3.3 | V |
| $V_{IN(OFF)}$ | 关断阈值电压<br>OFF Threshold Voltage | | 0.8 | --- | --- | |

**注 3 :**只有下桥驱动具有短路保护功能。
**注 4 :**当温度上升很多时IPM自身并不会自动关闭IGBT，也无$V_{FO}$输出。当温度超过用户设定的保护值时，控制器(MCU)应立即发出关断信号停止IPM工作。
**注 5 :**只有下桥驱动短路保护和$V_{D(L)}$电源欠压保护时才会输出故障信号，故障信号输出脉冲宽度$t_{FO}$依赖电容$C_{FO}$的容值，近似的计算公式如下: $C_{FO} \approx 14.3 * 10^{-6} * t_{FO}$ [F].。
**Note 3** : Short circuit protection is functioning only at the low-side.
**Note 4**: IPM doesn't shut down IGBTs and output fault signal automatically when temperature rises excessively. When temperature exceeds the protective level that user defined, controller (MCU) should stop the IPM immediately.
**Note 5**: The fault output pulse-width $t_{FO}$ depends on the capacitance value of $C_{FO}$ according to the following approximate equation：$C_{FO} \approx 14.3 * 10^{-6} * t_{FO}$ [F].

## 机械特性和额定值/Mechanical Characteristics and Ratings

| 符号<br>Symbol | 工作条件<br>Conditions | | 最小值<br>Min. | 典型值<br>Typ. | 最大值<br>Max. | 单位<br>Unit |
|---|---|---|---|---|---|---|
| 安装扭矩<br>Mounting Torque | 安装螺钉：-M3<br>Mounting Screw: - M3 | 推荐选用：1.18N·m<br>Recommended 0.62N.m | 0.98 | 1.18 | 1.47 | N • m |
| 端子拉力强度<br>Terminal pulling strength | 负载 19.6 N<br>Load 19.6 N | | 10 | --- | --- | s |
| 端子弯曲强度<br>Terminal bending strength | 负载 9.8 N, 90 度弯曲<br>Load 9.8 N, 90 degrees Bend | | 2 | --- | --- | times |
| 重量 Weight | | | --- | 43 | --- | g |
| 器件平面度<br>Device Flatness | 如图 4 /**Fig.4** | | 0 | --- | 200 | μm |

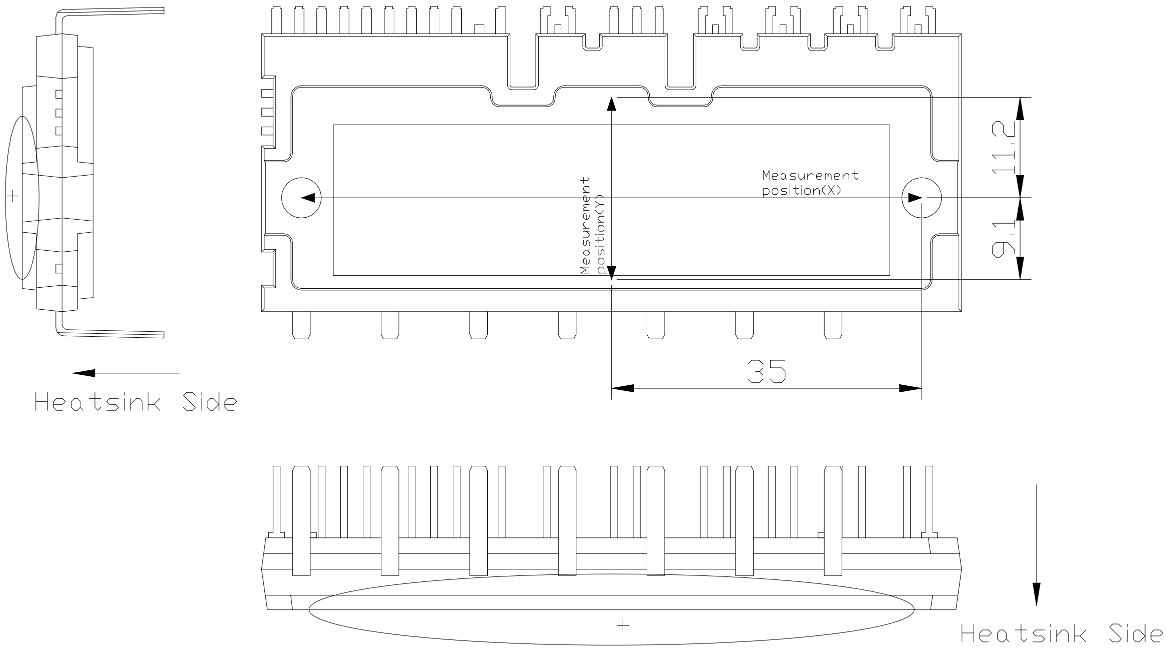



图4. 器件平整度
**Fig 4. Flatness Measurement Position**

## 推荐工作条件/Recommended Operating Conditions

| 符号 Symbol | 项目 Parameter | 工作条件 Conditions | 最小值 Min. | 典型值 Typ. | 最大值 Max. | 单位 Units |
|---|---|---|---|---|---|---|
| $V_{PN}$ | 电源电压 Supply Voltage | P -$N_U$,$N_V$,$N_W$之间 Applied between P-$N_U$,$N_V$,$N_W$ | 350 | 600 | 800 | V |
| $V_D$ | 控制电源电压 Control Supply Voltage | $V_{D(L)}$ -$COM_{(L)}$,$V_{D(H)}$-$COM_{(H)}$之间 Applied between $V_{D(HU)}$,$V_{D(HV)}$,$V_{D(HW)}$-$COM_{(H)}$, $V_{D(L)}$-$COM_{(L)}$ | 13.5 | 15.0 | 16.5 | V |
| $V_{BS}$ | 高端辅助电源电压 High-side Bias Voltage | $V_{B(U)}$ -$V_{S(U)}$,$V_{B(V)}$ -$V_{S(V)}$, $V_{B(W)}$ -$V_{S(W)}$之间 Applied between $V_{B(U)}$-$V_{S(U)}$,$V_{B(V)}$-$V_{S(V)}$, $V_{B(W)}$-$V_{S(W)}$ | 13.5 | 15.0 | 18.5 | V |
| $DV_D$/Dt, $DV_{DB}$/Dt | 控制电源电压波动 Control Supply variation | | -1 | --- | 1 | V/μs |
| $t_{DEAD}$ | 死区时间 Blanking Time for Preventing Arm-short | 适用于每个输入信号 For Each Input Signal | 3 | --- | --- | μs |
| PWIN(on) | 最小输入脉冲宽度 Minimum input pulse width | $V_D$=$V_{BS}$=15V,$I_C$≤70A, -20℃≤$T_C$≤100℃ （注 **6/Note 6**） | 2.0 | --- | --- | |
| PWIN(off) | | | 2.0 | --- | --- | |
| $f_{PWM}$ | 输入信号频率 PWM Input Signal | -20℃≤$T_C$≤100℃, -20℃ ≤$T_J$≤125℃ | --- | --- | 20 | KHz |

| | | | | | | |
|---|---|---|---|---|---|---|
| $V_{SEN}$ | 电压变化<br>Voltage for Current Sensing | $N_U,N_V,N_W$ -$COM_{(L)}$之间<br>(包括浪涌电压)<br>Applied between $N_U,N_V,N_W$-$COM_{(L)}$ (Including surge voltage) | -5 | --- | 5 | V |

注 **6:**如果输入脉冲宽度小于推荐值，IPM可能不会做出正确的响应。

**Note 6** : IPM might make no response for the input signal width less than PWIN(on)/off.

# IPM保护功能时序图/Time charts of IPM Protection Function

## 1. 短路保护/Short-Circuit Protection

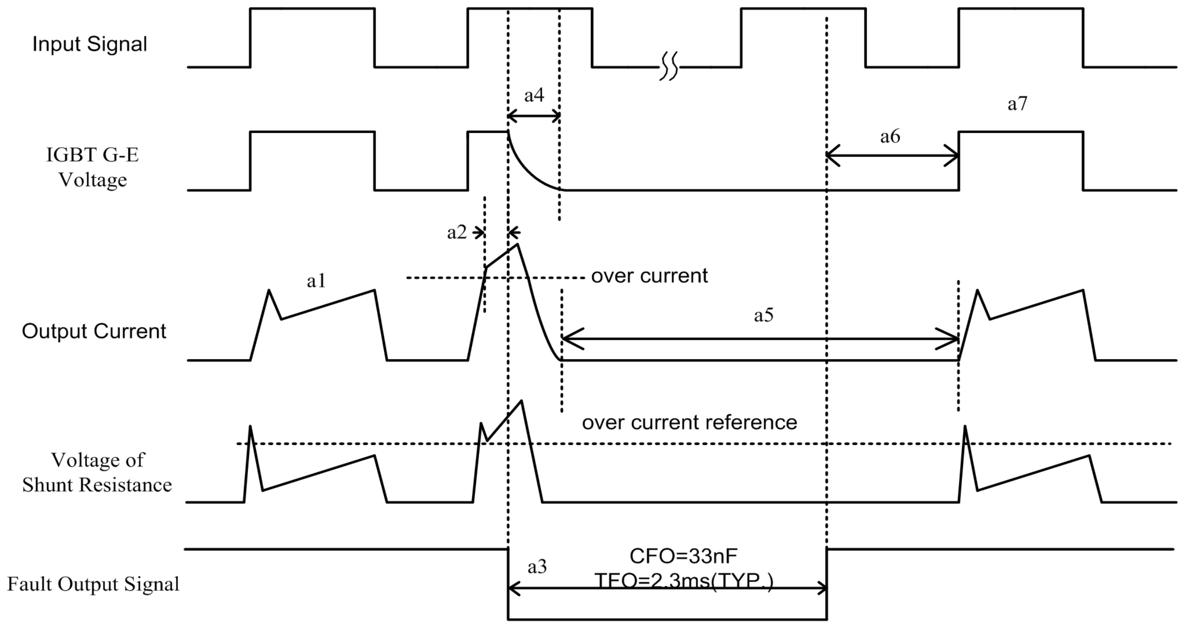



**图5. 短路保护时序**

**Fig 5. Short-Circuit Protection**

（仅下桥有，包含传感电阻和RC滤波器）

(Low-side only,with the external sense resistor and RC filter)

a1 IGBT正常工作，输出电流
Normal operation: IGBT ON and outputs curren.

a2 短路电流检测及滤波
Short-Circuit detection and filter.

a3 故障信号输出开始，脉宽由外部$C_{FO}$电容调节
Fault output timer operation starts: The pulse width of the $V_{FO}$ is set by the external capacitor $C_{FO}$

a4 IGBT软关断
IGBTs turn off softly.

a5 IGBT处于关断状态
IGBT OFF state.

a6 故障信号输出恢复高电平，但IGBT在下一个高电平输入信号时才会开通
$V_{FO}$ finishes output,but IGBTs don’t turn on until inputting next ON signal.

a7 当输入信号由L→H时，IGBT正常工作
Normal operation: IGBT ON and outputs current by next ON signal (L→H).

## 2. 下桥欠压保护/Low-Side Under-Voltage Protection

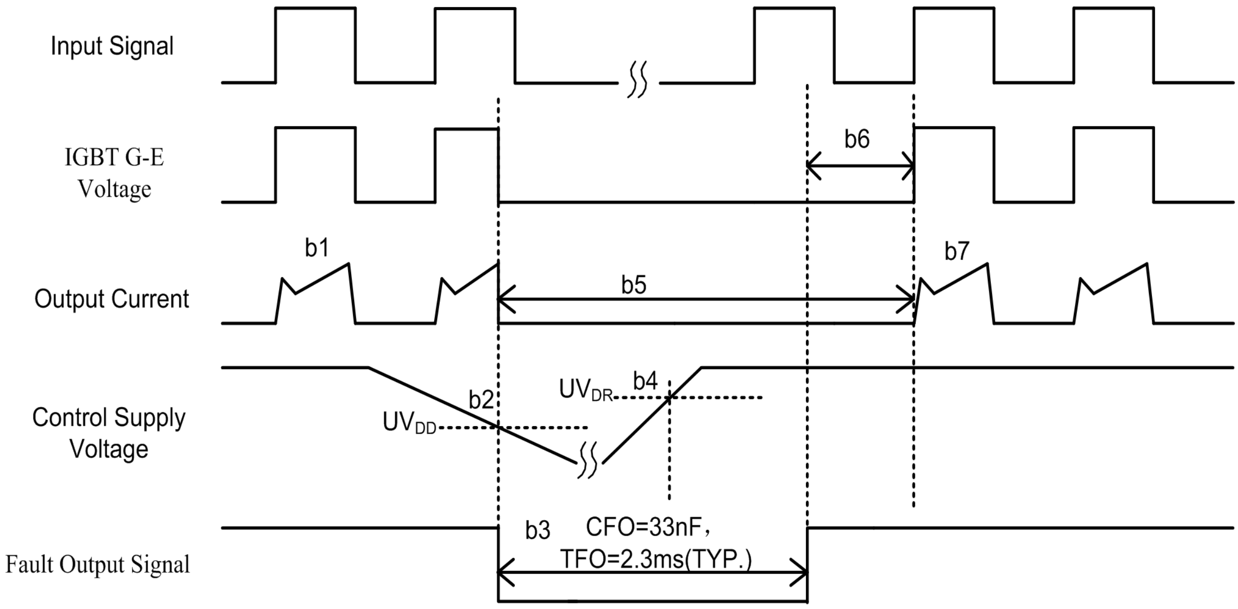



**图6. 下桥欠压保护时序**

**Fig 6. Low-Side Under-Voltage Protection**

b1 IGBT正常工作，输出电流
Normal operation: IGBT ON and outputs current.

b2 欠压检测（$UV_{DLD}$）
Under voltage detection ($UV_{DLD}$).

b3 故障信号输出低电平，脉宽由外部$C_{FO}$电容调节
Fault output timer operation starts: The pulse width of the $V_{FO}$ is set by the external capacitor $C_{FO}$.

b4 欠压恢复（$UV_{DLR}$）
Under voltage reset($UV_{DLR}$).

b5 IGBT处于关断状态
IGBT OFF state.

b6 故障信号输出恢复高电平，但IGBT在下一个高电平输入信号时才会开通
$V_{FO}$ finishes output,but IGBTs don’t turn on until inputting next ON signal.

b7 当输入信号由L→H时，IGBT正常工作

b8 Normal operation: IGBT ON and outputs current by next ON signal(L→H).

### 3. 上桥欠压保护/High-Side Under-Voltage Protection

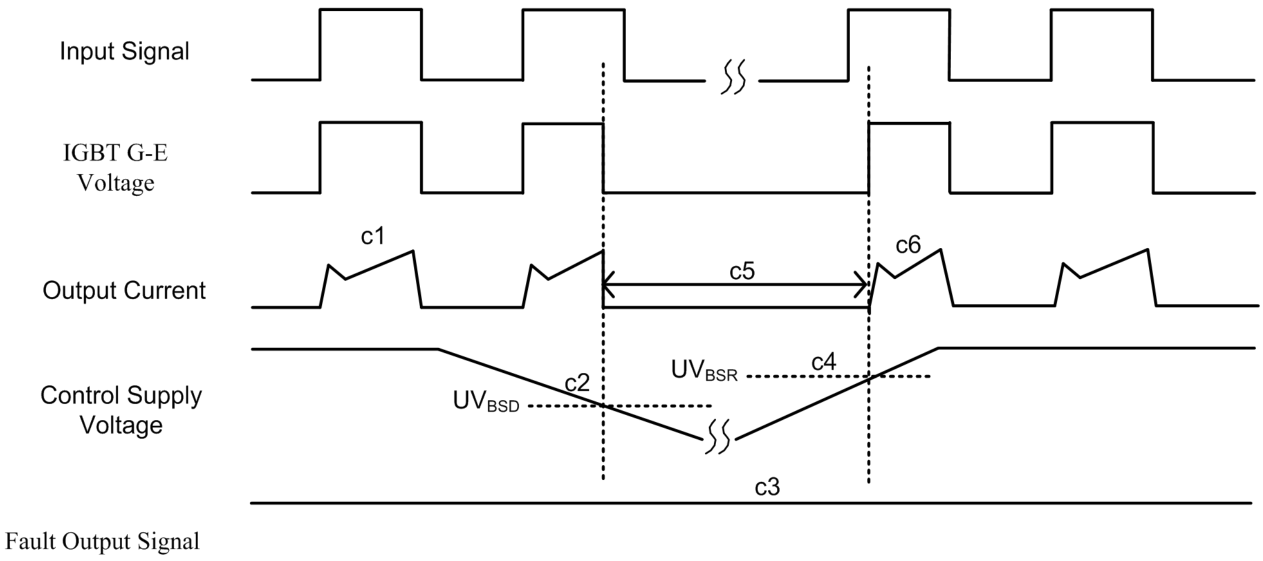



**图7. 上桥欠压保护时序**

**Fig 7.　High-Side Under-Voltage Protection**

c1　IGBT正常工作，输出电流
Normal operation: IGBT ON and outputs current.
c2　欠压检测（$UV_{BSD}$）
Under voltage detection（$UV_{BSD}$）.
c3　故障信号保持高电平，上桥欠压无故障信号输出
No fault output signal.
c4　欠压恢复（$UV_{BSR}$）
Under voltage reset（$UV_{BSR}$）.
c5　IGBT处于关断状态
IGBT OFF state.
c6　欠压已恢复，但IGBT在下一个高电平输入信号时才会开通
Under voltage reset,but IGBTs don’t turn on until inputting next ON signal.
c7　当输入信号由L→H时，IGBT正常工作
Normal operation: IGBT ON and outputs current by next ON signal(L→H).

# 典型应用电路图
# Typical Application Circuit

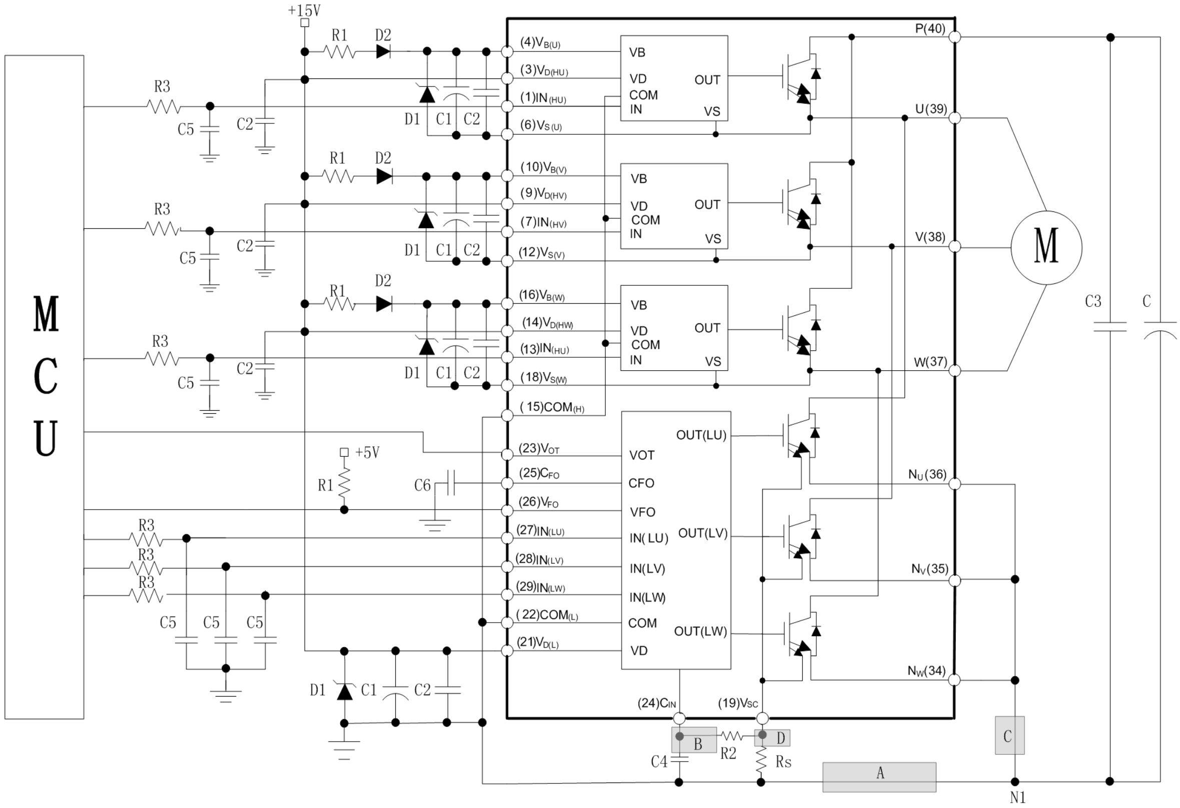


图8.典型应用电路图
**Fig 8. Typical Application Circuit**

注:

1. 如果驱动电源的地与功率地共线的话，功率地线的波动可能导致模块误动作。因此，推荐将驱动地与功率地通过单点相连，该点即是$N_U$/$N_V$/$N_W$ 与功率地线相连接的点。
2. 为了防止浪涌电压带来的损坏，平滑电容和 P&N1 端子间的布线应尽可能的短。推荐在P-N1端加入一个0.1~0.22μF的吸收电容C3。
3. 用于防止保护电路误动作的RC滤波器的时间常数R2C4应选在1.5~2 μs的范围内，且R2、C4要选择温度离散性小的温度补偿型器件。另外，短路保护中断时间可能会随布线方式而变化。
4. 所有的电容都应尽可能地靠近IPM引脚放置（C1选择温度特性和频率特性优良的电解电容，C2选择温度特性、频率特性和直流偏置特性优良的陶瓷电容）。
5. 为了防止浪涌损坏，建议在每一对驱动电源端子间加入一个稳压二极管D1(24V/1W)。
6. 为了防止短路保护误动作，从$V_{SC}$端子到$C_{IN}$滤波器的连线应从靠近传感电阻端的D点分离。另外，走线应尽可能短。
7. 对于传感电阻，推荐采用精度（含温度特性在内）在±1%以内、低感型电阻。推荐电阻的功率为1/8W 以上，但最终需要在具体的应用系统中评价后确定。
8. 为防止发生错误，A、B、C处的布线都应尽可能地短。
9. $V_{FO}$输出是漏极开路型，应通过一个电阻上拉到5V或15V电源的正极，该上拉电阻应限制电流$I_{FO}$在2mA以内。当上拉至5V电源时，推荐阻值为10kΩ。
10. 故障信号$V_{FO}$输出脉冲宽度（$t_{FO}$）由连接在$C_{FO}$端的电容C6决定，$C6 \approx 14.3 * 10^{-6} * t_{FO}$ [F]。
11. 自举二极管D2 应选用高耐压（VRRM=1200V或以上）、快恢复（trr=100ns或更小）二极管。

12. 驱动输入逻辑是高电平有效。下桥驱动输入电路中内置了一个3.3kΩ（最小值）的下拉电阻。为防止误动作，输入信号线应尽可能地短。强烈推荐在输入信号线上加RC滤波器（例如：R3=100 Ω，C5=1000pF），但要注意输入信号电平应满足开通和关断阈值电压的要求。由于模块内部集成了HVIC，使得无需光耦或变压器而直接将MCU/DSP 和模块相连接成为可能。

**Note:**

1. If control GND and power GND are patterned by common wiring, it may cause malfunction by fluctuation of power GND level. It is recommended to connect
2. To prevent surge destruction, the wiring between the smoothing capacitor and the P, N1 terminals should be as short as possible. Generally inserting a 0.1μ~0.22μF snubber capacitor C3 between the P-N1 terminals is recommended.
3. R2,C4 of RC filter for preventing protection circuit malfunction is recommended to select tight tolerance,temp-compensated type.The time constant R2C4 should be set so that SC current is shut down within 2us(in the range 1.5~2us).
4. All capacitors should be mounted as close to the terminals of the IPM as possible. (C1: good temperature, frequency characteristic electrolytic type, and C2: 0.22μ~2.0μF, good temperature, frequency and DC bias characteristic ceramic type are recommended).
5. It is recommended to insert a Zener diode D1 (24V/1W) between each pair of control supply terminals to prevent surge destruction.
6. To prevent erroneous SC protection, the wiring from $V_{SC}$ terminal to $C_{IN}$ filter should be divided at the point D that is close to the terminal of sense resistor. And the wiring should be patterned as short as possible.
7. For sense resistor, the variation within 1%(including temperature characteristics), low inductance type is recommended. And the over 1/8W is recommended, but it is necessary to evaluate in your real system finally.
8. To prevent erroneous operation, the wiring of A, B, C should be as short as possible.
9. $V_{FO}$ output is open drain type. It should be pulled up to MCU or control power supply (e.g. 5V,15V) by a resistor that makes $I_{FO}$ up to 2mA. In the case of pulled up to 5V, 10k is recommended.
10. Fault output width ($t_{FO}$) can be set by the capacitor C6 connected to $C_{FO}$ terminal,C6 ≈ 14.3 * 10-6 * $t_{FO}$ [F].
11. High voltage (VRRM =1200V or more) and fast recovery diode (trr=less than 100ns or less) should be used for D2 in the bootstrap circuit.
12. Input drive is High-active type. There is a min. 3.3k pull-down resistor in the input circuit of low side control IC. To prevent malfunction, the wiring of each input should be as short as possible. And it is strongly recommended to insert RC filter (e.g. R3=100,and C5=1000pF) and confirm the input signal level to meet the turn-on and turn-off threshold voltage. Thanks to HVIC inside the module, direct coupling to MCU without any opto-coupler or transformer isolation is possible.

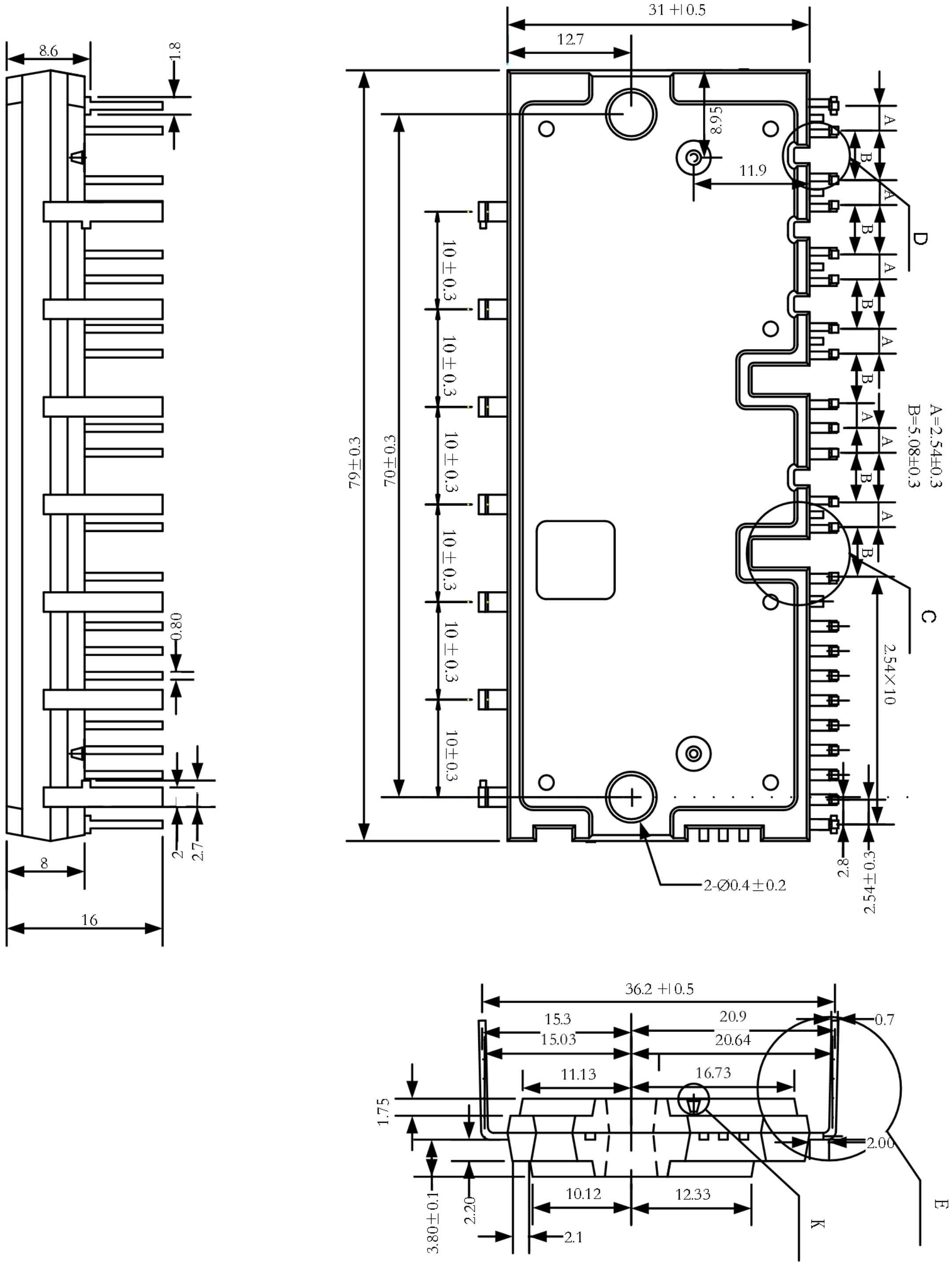
## 包装/Packing

| 包装<br>package | pcs/料管<br>pcs/tube | 料管/箱<br>tube/ box | pcs/箱<br>pcs/ box |
|---|---|---|---|
| 料管/tube | 6 | 30 | 180 |

## 封装轮廓详图/ Detailed Package Outline Drawings

封装/Package：DIP30-7931

（单位/**Unit**：mm）



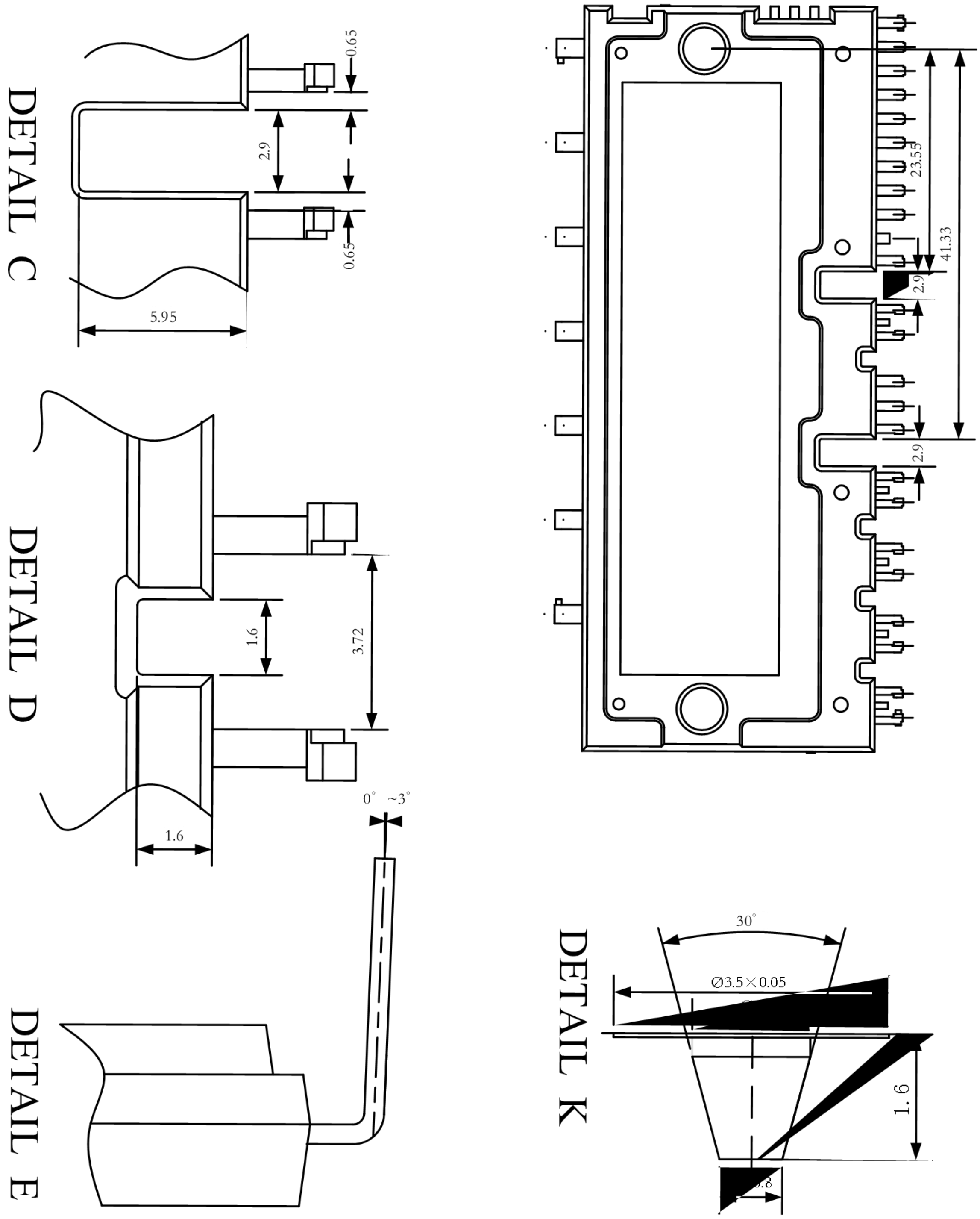



图9. 封装轮廓详图

**Fig 9. Package Outline Drawings**

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