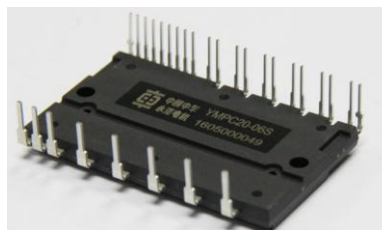


52.5mm×31mm 智能功率模块

52.5mm×31mm Integrated power module



$V_{CES}=600V$   $I_C=20A$

### 特性

- 上桥臂 IGBT :
  - 驱动电路
  - 高压高速的电平翻转
  - 低压保护电路(UL)
- 下桥臂 IGBT :
  - 驱动电路
  - 低压保护电路 ( UL )
  - 短路保护电路 ( SC )
- 故障信号:
  - 可以处理短路故障和欠压故障
- 输入接口的电压 :
  - 与 3V 及 5V 输入电平兼容
  - 高电平有效

### Features

- For upper-leg IGBTs :
  - Drive circuit
  - High voltage high-speed level speed
  - Control supply under-voltage protection
- For lower-leg IGBTs :
  - Drive circuit
  - Control supply under-voltage protection
  - Short circuit (SC) protection
- Fault signaling:
  - Corresponding to an SC fault (lower-leg IGBT) or a UV fault (lower-side supply)
- Input interface:
  - Compatible 3V and 5V
  - High active

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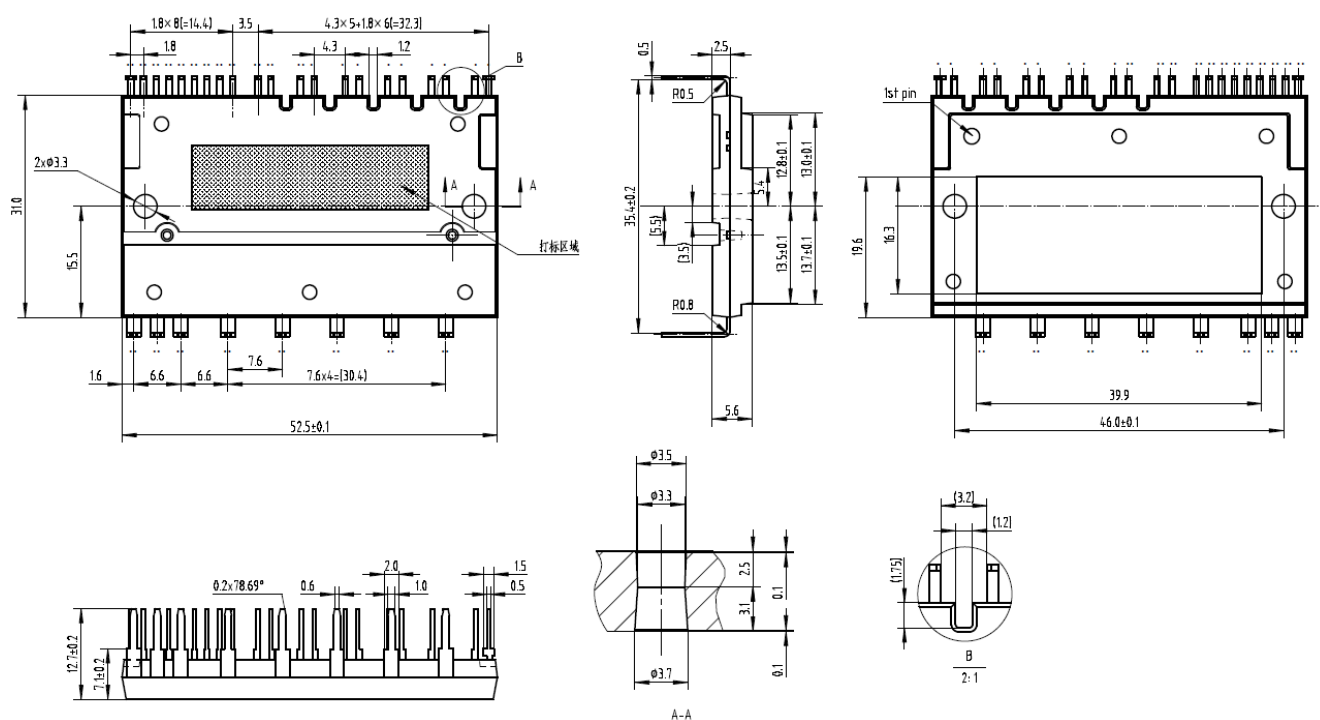
## 应用领域

- 空调、洗衣机、冰箱等变频家用电器
- 小功率工业传动

## Applications

- Household equipment –air conditioner, washing machine and refrigerator
- Industrial drive for low power

## Outline drawing/外形尺寸



**Note :** all dimensions are shown in millimeters

**注意：**所有的尺寸均为毫米

**Maximum rated values**( $T_j=25^{\circ}\text{C}$  , unless otherwise noted)/**最大额定值** ( 测试均在  $T_j=25^{\circ}\text{C}$  下完成 )

### Inverter part/逆变部分

Parameter 参数	Symbol 符号	Conditions 条件	Ratings 等级	Unit 单位
直流母线电源电压 Supply voltage	$V_{CC}$	Applied between P-NU,NV,NW	450	V
直流母线电源电压(浪涌) Supply voltage(surge)	$V_{CC}(\text{surge})$	Applied between P-NU,NV,NW	500	V
集电极发射极之间电压 Collector-emitter voltage	$V_{CES}$		600	V
每个 IGBT 集电极电流 Each IGBT collector current	$\pm I_C$	$T_C=25^{\circ}\text{C}$	20	A
每个 IGBT 集电极电流(峰值) Each IGBT collector current(peak)	$\pm I_{CP}$	$T_C=25^{\circ}\text{C}$ , 小于 1ms	40	A
结温 Junction temperature	$T_j$		$-20\sim+125$	$^{\circ}\text{C}$

### Control (protection) part/控制 ( 保护 ) 部分

Parameter 参数	Symbol 符号	Conditions 条件	Ratings 等级	Unit 单位
控制电源电压 Control supply voltage	$V_D$	Applied between $V_{P1}-V_{NC}$ , $V_{N1}-V_{NC}$	20	V
控制电源电压 Control supply voltage	$V_{DB}$	Applied between $V_{UFB}-V_{UFS}$ , $V_{VFB}-V_{VFS}$ , $V_{WFB}-V_{WFS}$	20	V
输入信号端子电压 Input voltage	$V_{IN}$	Applied between $U_P/V_P/W_P-$ $V_{NC}, U_N/V_N/W_N-V_{NC}$	$-0.5\sim V_D+0.5$	V
故障输出端子电压 Fault output supply voltage	$V_{FO}$	Applied between $F_0-V_{NC}$	$-0.5\sim V_D+0.5$	V
故障输出端子电流 Fault output current	$I_{FO}$	Sink current at $F_0$ terminal	1	mA
电流检测输入端子电压 Current sensing input voltage	$V_{SC}$	Applied between $ITRIP-V_{NC}$	$-0.5\sim V_D+0.5$	V

**Total system/整个系统**

Parameter 参数	Symbol 符号	Conditions 条件	Ratings 等级	Unit 单位
工作温度 Module case operation temperature	T <sub>c</sub>		-20~+100	°C
储存温度 Storage temperature	T <sub>STG</sub>		-40~+125	°C
绝缘电压 Isolation voltage	V <sub>iso</sub>	Sinusoidal 60Hz , AC 1 Min, all pin to heat-sink plate	2500	V <sub>rms</sub>

**Mechanical characteristics and ratings/机械特性和额定值**

Parameter 参数	Conditions 条件		Min. 最小值	Typ. 特征值	Max. 最大值	Unit 单位
安装扭矩 Mounting torque	Mounting screw : M3	Recommended : 0.78N•m	0.59	—	0.98	N•m
重量 Weight			—	24	—	g
散热片平整度 Heat-sink flatness			-50	—	100	um

**Electrical characteristics T<sub>j</sub>=25°C , unless otherwise noted)/电气特性 ( 测试均在 T<sub>j</sub>=25°C****下完成 )****Inverter part/逆变部分**

Parameter 参数	Symbol 符号	Conditions 条件		Min. 最小值	Typ. 特征值	Max. 最大值	Unit 单位
集电极发射极间饱和电压 Collector-emitter saturation voltage	V <sub>ce(sat)</sub>	V <sub>D</sub> =V <sub>DB</sub> =15V V <sub>IN</sub> =5V	I <sub>C</sub> =20A, T <sub>j</sub> =25°C	—	2.0	2.4	V
续流二极管正向压降 FWD forward voltage	V <sub>EC</sub>	T <sub>j</sub> =25°C , -I <sub>C</sub> =20A , V <sub>IN</sub> =0V		—	2.0	2.4	V
开关时间 Switching times	t <sub>on</sub>	V <sub>CC</sub> =300V, V <sub>D</sub> =V <sub>DB</sub> =15V I <sub>C</sub> =20A, T <sub>j</sub> =25°C , V <sub>IN</sub> =0-5V Inductive load (upper-lower arm)		0.3	0.6	1.2	us
	t <sub>rr</sub>			—	0.07	—	us
	t <sub>c(on)</sub>			—	0.26	0.50	us
	t <sub>off</sub>			—	0.9	1.5	us
	t <sub>c(off)</sub>			—	0.17	0.35	us
集电极发射极间泄露电流 Collector-emitter cut-off current	I <sub>CES</sub>	V <sub>CE</sub> =V <sub>CES</sub>	T <sub>j</sub> =25°C	—	—	20	uA

## Control (protection) part/控制 (保护) 部分

Parameter 参数	Symbol 符号	Conditions 条件		Min. 最小值	Typ. 特征值	Max. 最大值	Unit 单位
电路电流 Current circuit	$I_D$	$V_D = V_{DB} = 15V$ $V_{IN} = 5V$	Total of $V_{N1}-V_{NC}$ , $V_{P1}-V_{NC}$	—	—	1.50	mA
			$V_{UFB}-V_{UES}, V_{VFB}-V_{VES},$ $V_{WFB}-V_{WFS}$	—	—	0.55	mA
		$V_D = V_{DB} = 15V$ $V_{IN} = 0V$	Total of $V_{P1}-V_{NC}, V_{N1}-V_{NC}$	—	—	1.50	mA
			$V_{UFB}-V_{UES}, V_{VFB}-V_{VES},$ $V_{WFB}-V_{WFS}$	—	—	0.55	mA
故障输出端子电压 Fault output voltage	$V_{FOH}$	$V_{SC} = 0V, I_{FO}$ terminal pull-up 5V with 10k		4.95	—	—	V
	$V_{FOL}$	$V_{SC} = 1V, I_{FO} = 1mA$		—	—	0.90	V
短路保护动作电平 Short circuit trip level	$V_{SC(ref)}$	$T_j = 25^\circ C, V_D = 15V$		0.37	0.46	0.65	V
输入信号端子电流 Input current	$I_{IN}$	$V_{IN} = 5V$		0.7	0.9	1.3	mA
控制电源欠压保护阈值 Control supply under-voltage protection	$U_{VDBt}$	$T_j = 25^\circ C$	Trip level	9.5	—	11.5	V
	$U_{VDBr}$		Reset level	10.4	—	12.8	V
	$U_{VDt}$		Trip level	9.5	—	11.5	V
	$U_{VDr}$		Reset level	11.0	—	12.8	V
故障输出信号脉宽 Fault output pulse width	$t_{FO}$	$C_{FO} = 22nF$		0.05	0.1	—	ms
开通阈值电压 ON Threshold voltage	$V_{th(on)}$	$U_P, V_P, W_P, U_N, V_N, W_N - V_{NC}$ 之间		—	2.1	2.4	V
关断阈值电压 OFF Threshold voltage	$V_{th(off)}$			0.7	0.9	—	V
开通/关断阈值电压差值 ON/OFF Threshold hysteresis voltage	$V_{th(hys)}$			0.5	1.2	—	V

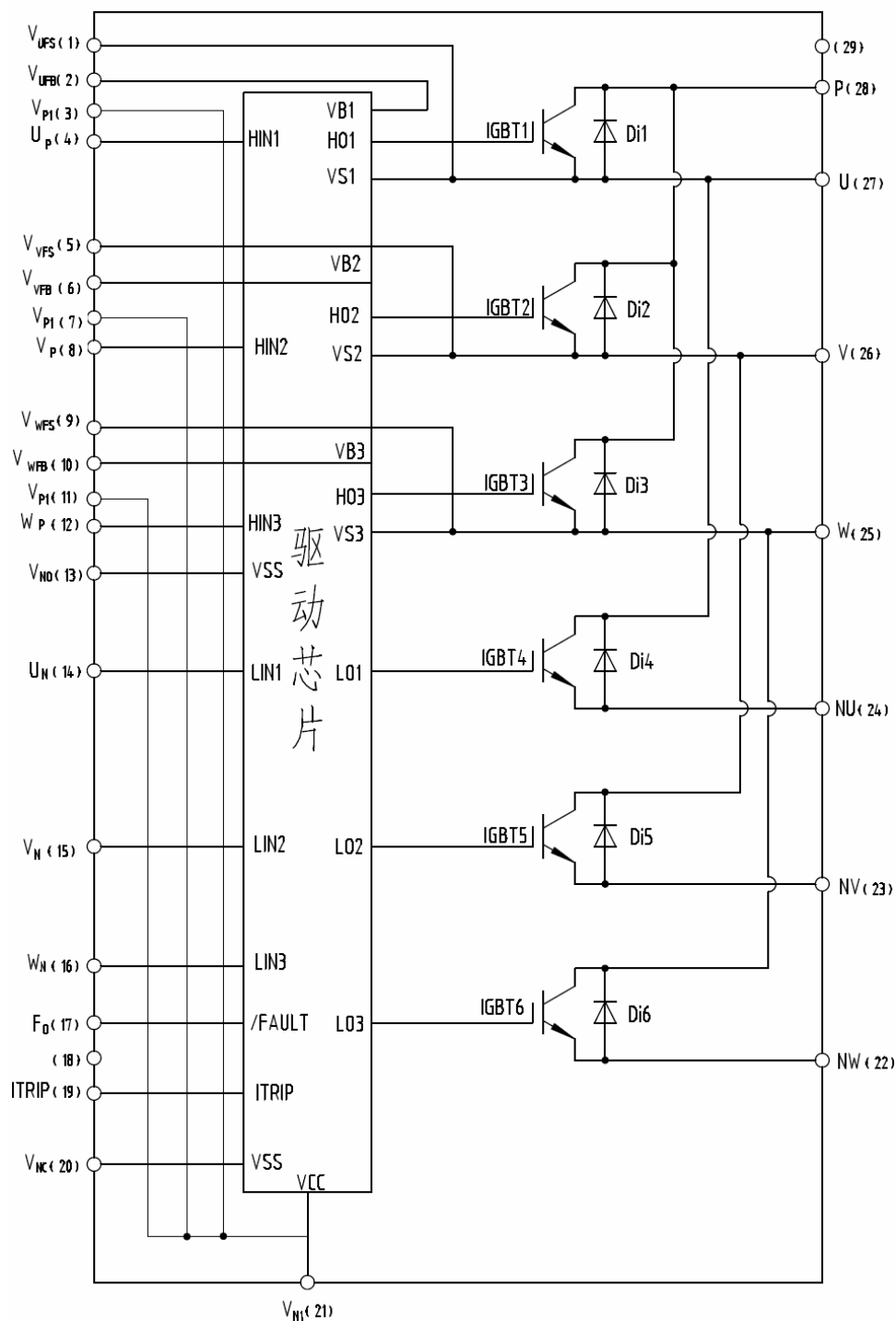
## Recommended operation conditions/建议工作条件

Parameter 参数	Symbol 符号	Conditions 条件		Min. 最小值	Typ. 特征值	Max. 最大值	Unit 单位
供电电压 ( 直流母线电压 ) Supply voltage	V <sub>CC</sub>	Applied between P-N <sub>U</sub> ,N <sub>V</sub> ,N <sub>W</sub>		0	200	400	V
控制电源电压 Control supply voltage	V <sub>D</sub>	Applied between V <sub>N1</sub> -V <sub>NC</sub> , V <sub>P1</sub> -V <sub>NC</sub>		13.5	15.0	16.5	V
控制电源电压 Control supply voltage	V <sub>DB</sub>	Applied between V <sub>UFB</sub> -V <sub>UFS</sub> , V <sub>FB</sub> -V <sub>VFS</sub> , V <sub>WFB</sub> -V <sub>WFS</sub>		13.5	15.0	18.5	V
控制电压纹波 Control supply variation	ΔV <sub>D</sub> , ΔV <sub>DB</sub>			-1	—	1	V
防止桥臂直通的死区时间 Arm shoot-through blocking time	t <sub>dead</sub>	For each input signal , T <sub>c</sub> ≤100℃		2	—	—	us
PWM 输入频率 PWM input frequency	f <sub>pwm</sub>	T <sub>c</sub> ≤100℃,T <sub>j</sub> ≤125℃		—	—	20k	Hz
允许输出电流的有效值 Output r.m.s current	I <sub>o</sub>	V <sub>CC</sub> =200V,V <sub>D</sub> =V <sub>DB</sub> = 15V PF=0.8 , sinusoidal PWM T <sub>c</sub> ≤100℃,T <sub>j</sub> ≤125℃	f <sub>pwm</sub> =5Hz	—	—	21	Arms
			f <sub>pwm</sub> =15Hz	—	—	16	
允许输入信号的最小脉宽 Minimum input pulse width	P <sub>WMIN</sub> (ON)	200≤V <sub>CC</sub> ≤350V 13.5≤V <sub>D</sub> ≤16.5V 13.0≤V <sub>DB</sub> ≤18.5V -20℃≤T <sub>c</sub> ≤100℃ N-line wiring inductance less than10nH		0.3	—	—	us
	P <sub>WMIN</sub> (Off)		Blow rated current	1.5	—	—	
			Between 1-1.7 rated current	3.0	—	—	
			Between 1.7-2 rated current	3.6	—	—	
V <sub>NC</sub> 上的电压波动 V <sub>NC</sub> voltage variation	V <sub>NC</sub>	Between V <sub>NC</sub> -N <sub>U</sub> ,N <sub>V</sub> ,N <sub>W</sub> (including surge)		-5.0	—	5.0	V
结温 Junction temperature	T <sub>j</sub>			-20	—	125	℃

## Pins definition/引脚定义

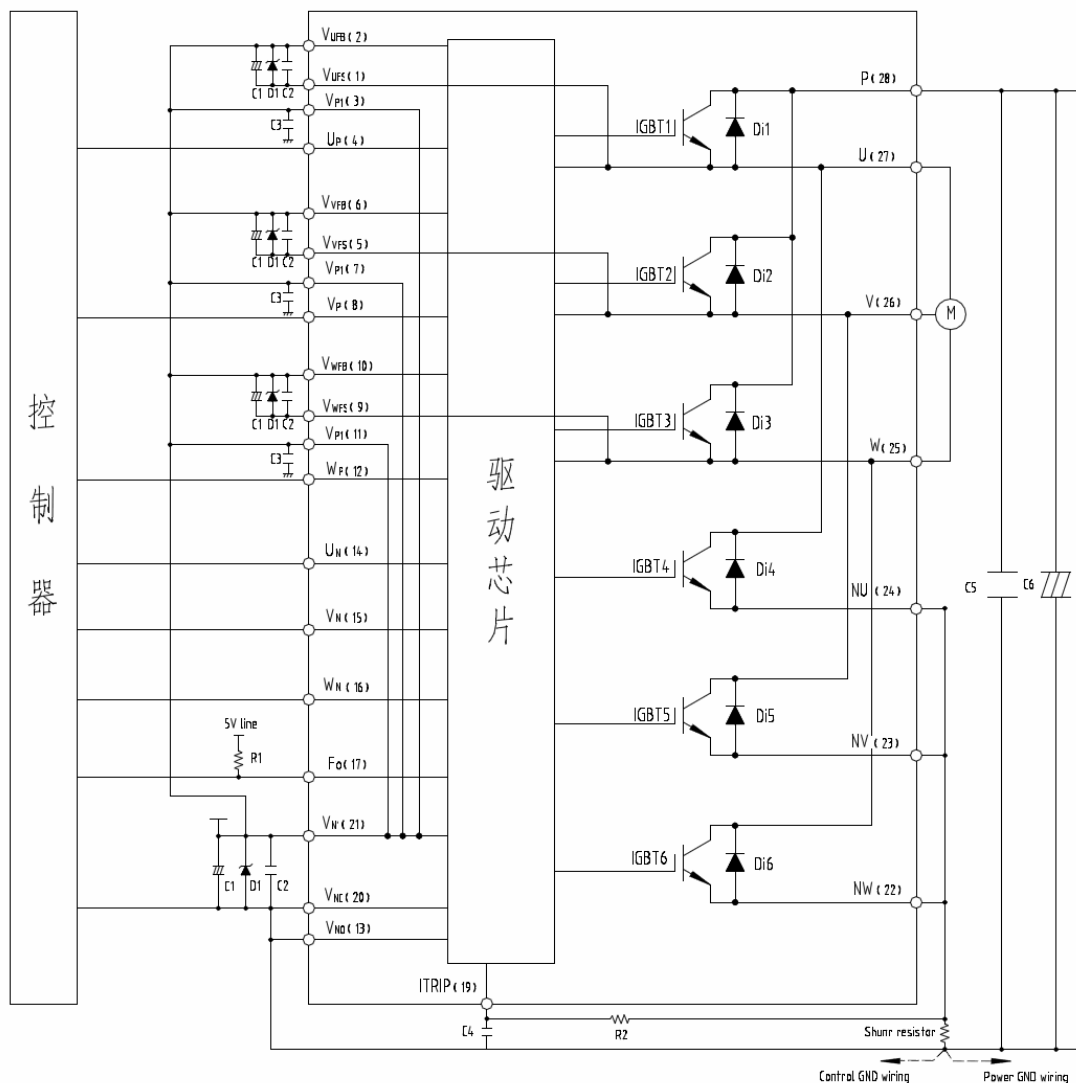
序号 Number	管脚名称 Pin name	引脚说明 Pins explanation	英文描述 English description
1	V <sub>UFS</sub>	上桥臂 U 相驱动地端	U-phase P-side drive supply GND terminal
2	V <sub>UFB</sub>	上桥臂 U 相驱动正端	U-phase P-side drive supply positive terminal
3	Nc	空引脚	Dummy-pin
4	U <sub>P</sub>	上半桥 U 相逻辑输入端	U-phase P-side control input terminal
5	V <sub>VFS</sub>	上桥臂 V 相驱动地端	V-phase P-side drive supply GND terminal
6	V <sub>VFB</sub>	上桥臂 V 相驱动正端	V-phase P-side drive supply positive terminal
7	V <sub>P1</sub>	空引脚	Dummy-pin
8	V <sub>P</sub>	上半桥 V 相逻辑输入端	V-phase P-side control input terminal
9	V <sub>WFS</sub>	上桥臂 W 相驱动地端	W-phase P-side drive supply GND terminal
10	V <sub>WFB</sub>	上桥臂 W 相驱动正端	W-phase P-side drive supply positive terminal
11	V <sub>P1</sub>	空引脚	Dummy-pin
12	W <sub>P</sub>	上半桥 W 相逻辑输入端	W-phase P-side control input terminal
13	V <sub>NO</sub>	门极控制参考地端	N-side IGBT gate signal referenced GND terminal
14	U <sub>N</sub>	下桥臂 U 相逻辑输入端	U-phase P-side control input terminal
15	V <sub>N</sub>	下桥臂 V 相逻辑输入端	V-phase P-side control input terminal
16	W <sub>N</sub>	下桥臂 W 相逻辑输入端	W-phase P-side control input terminal
17	/Fo	故障信号输出端	Fault signal output terminal
18	Nc	空引脚	Dummy-pin
19	ITRIP	过流电流跳闸电压检测端	SC current trip voltage detecting terminal
20	V <sub>NC</sub>	下桥臂参考地端	P-side control supply GND terminal
21	V <sub>N1</sub>	控制电源正端	P-side control supply positive terminal
22	N <sub>W</sub>	逆变器直流电源负端 ( W 相 )	WN-phase IGBT emitter
23	N <sub>V</sub>	逆变器直流电源负端 ( V 相 )	VN-phase IGBT emitter
24	N <sub>U</sub>	逆变器直流电源负端 ( U 相 )	UN-phase IGBT emitter
25	W	逆变器 W 相输出端	W-phase output terminal
26	V	逆变器 V 相输出端	V-phase output terminal
27	U	逆变器 U 相输出端	U-phase output terminal
28	P	逆变器直流电压正端	Inverter DC-link positive terminal
29	Nc	空引脚	Dummy-pin

## IPM internal circuit/IPM 内部电路





## Typical IPM application circuit example/典型 IPM 应用举例



注意/note:

1、如果控制地线和功率地线重叠，则可能导致因功率线上的电压波动引起模块的误动作。建议控制地和功率地线在靠近分流电阻的端子部位进行相连。

If control GND is connected to power GND by broad pattern, it may cause malfunction by power GND fluctuation. It is recommended to connect control GND and power GND at only a point.

2、输入的驱动为高电平有效，在控制芯片的内部集成了一个 5kΩ 的下拉电阻。为了防止误动作，每个输入线应尽可能的短。当接入 RC 滤波电路时，应确保输入信号满足开通、关断阈值电压的要求。

Input drive is High-active type. There is a 5kΩ 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.

3、由于内置 HVIC，是的采用隔离电路而直接与控制器相连成为可能。

Thanks to HVIC inside the module, direct coupling to MCU without any opto-coupler or transformer isolation is possible.

4、/Fault 引脚的输出为漏极开路型且为低电平输入有效，它表示这门极驱动的状态。该端子通过一个电阻上拉至控制电源（比如 5V），为了限制其电流在 1mA 之内必须串联一个适当的限流电阻（当上拉到 5V 电源时，需要至少 5kΩ 的上拉电阻，推荐值为 10kΩ）。

/Fault is an active low open-drain output indicating the status of the gate drive. In order to limit its circuit less than 1mA, there must be a series resistor .When it is pulled up to the positive side of a 5V power supply ,the resistor is about 10kΩ .

5、为了避免浪涌电压的破坏，推荐在每对控制端子近旁加一个齐纳二极管 D1(24V/1W)。

It is recommended to insert a Zener diode(24V/1W) between each pair of control supply terminal to prevent surge destruction.

6、为了避免浪涌损坏，平滑电容与 P 和 GND 端子之间的接线应尽可能短，通常推荐在 P 和 GND 端子间加一 0.1-0.22uF 的吸收电容 C<sub>s</sub>。

To prevent surge destruction, the wiring between the smoothing capacitor and the P, GND terminal should be as short as possible. Generally a 0.1-0.22uFsnubber between the P-GND terminal is recommended.

7、所有的电容应尽可能靠近模块端子放置（C<sub>1</sub> 推荐使用具有良好频率和温度特性的电解电容；C<sub>2</sub>, C<sub>3</sub>: 0.22-2uF 推荐使用具有良好频率、温度和直流偏置特性的陶瓷电容）。

All capacitor should be mounted as close to the terminals of the IPM as possible.(C<sub>1</sub>:good temperature, frequency characteristic electrolytic type, and C<sub>2</sub>,C<sub>3</sub>: good temperature, frequency and DC bias characteristic ceramic type are recommended. )

9、当发生过流时，内部的阻断时间的典型值为 65us，无需通过外接电容设置。

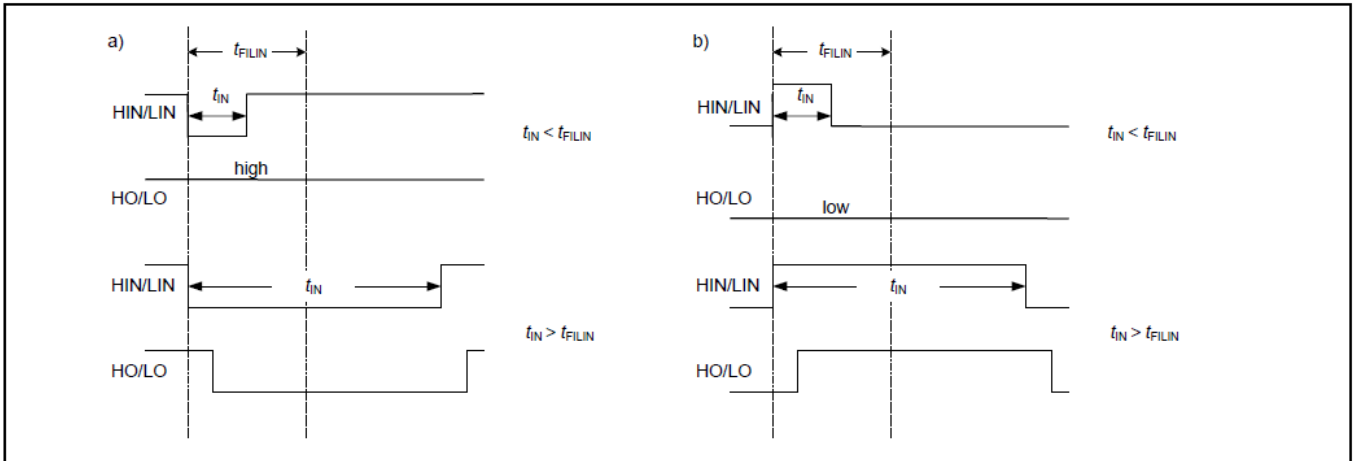
When an overcurrent occurs, the internal blocking time is typically 65us without external capacitors.

10、芯片内部高度集成自举二极管。

There is an highly integrated bootstrap diode inside the chip.

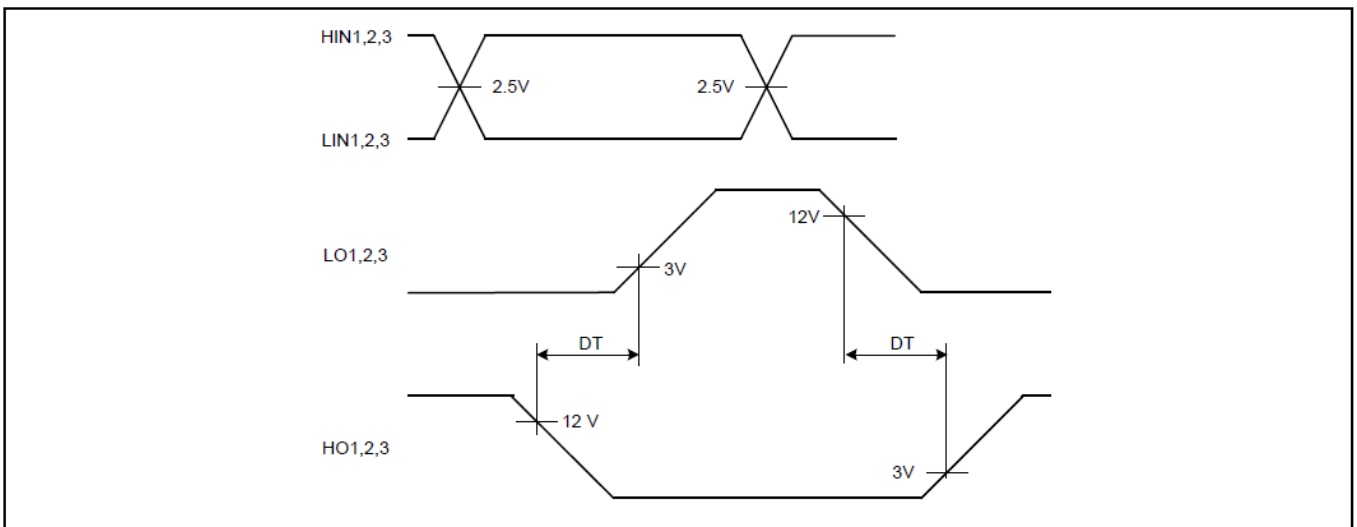
## Drive IC Timing diagram/驱动芯片时序图表

### Timing of short pulse suppression



It is anyway recommended for proper work of the driver not to provide input pulse-width lower than 1 $\mu$ s.  
为了保证驱动可以正常的工作，建议输入脉冲的宽度不小于 1 $\mu$ s。

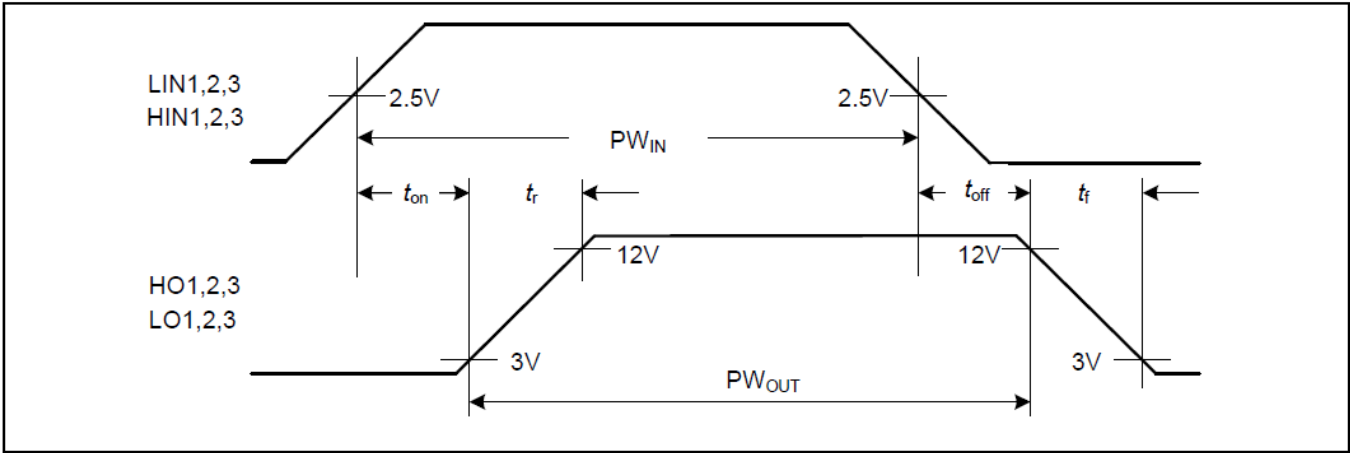
### Timing of internal dead time/内部的死区时间



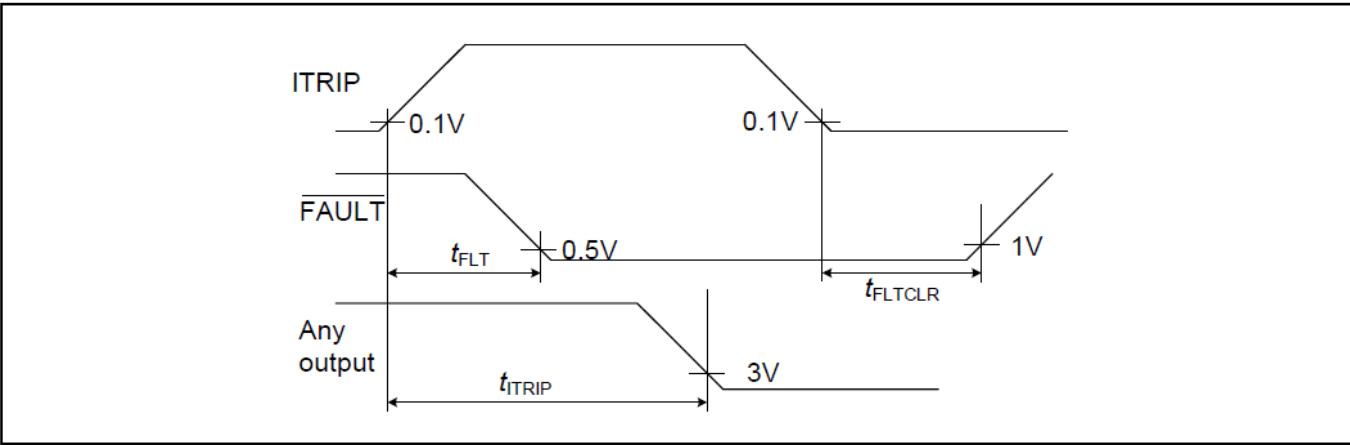
A dead-time insertion of typ. 360ns is also provided, in order to reduce cross-conduction of the external power switches.  
为了减少外部功率开关器件的开关损耗，内部提供一个 360ns 的死区时间。

Input to output propagation delay times and switching times definition

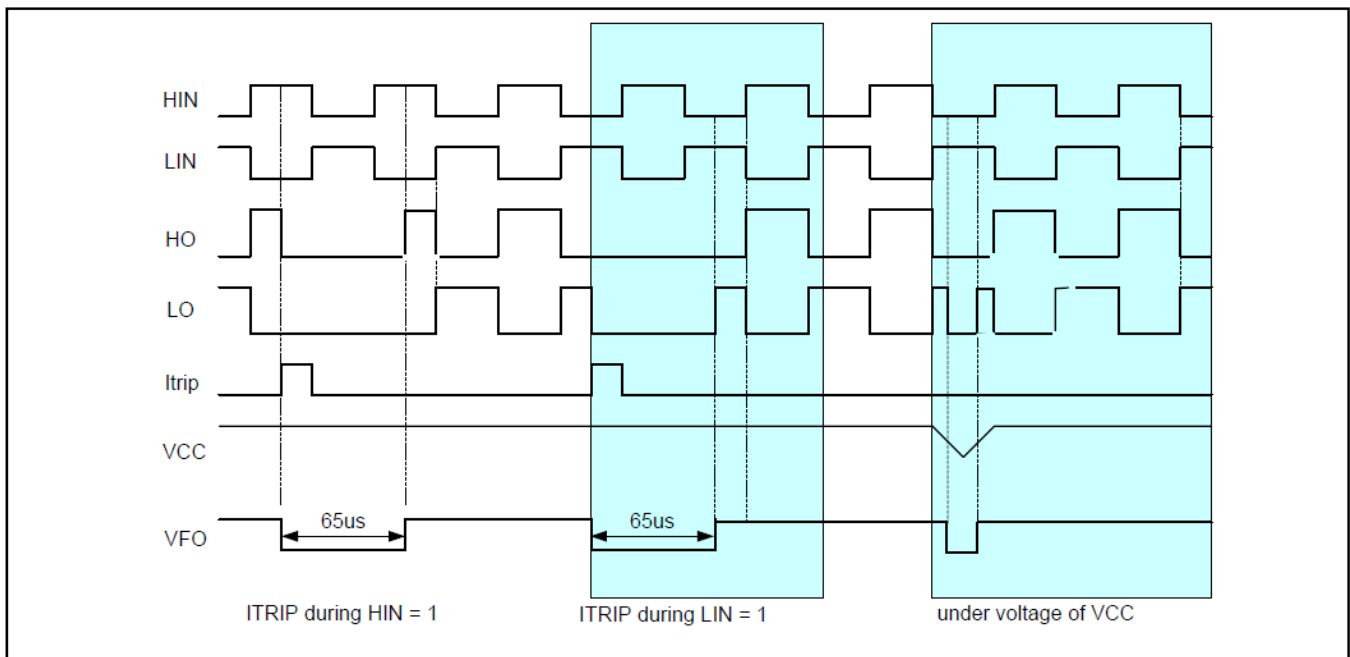
输入输出传输延迟时间和开关时间定义



ITRIP-timing , FAULT clear and /FAULT timing 过流、故障时序及故障清除



## Protective timing chart/保护时间表



When an overcurrent occurs, the internal blocking time is typically 65us without any external capacitor.

当发生过流时，内部的阻断时间的典型值为 65us，无需通过外接电容设置。

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