描述/Description

- XNS30S73E6基于Trench FS-IGBT技术，是一款先进的DIP25 IPM，为交流感应、直流无刷电机和PMSM电机提供非常全面的高性能逆变器输出平台。
  XNS30S73E6 is an Advanced DIP25 IPM Based on Trench FS-IGBT Technology, Providing a Fully-featured, High-performance Inverter Output Stage for AC Induction, BLDC, and PMSM Motors.
- XNS30S73E6综合优化了IGBT的栅极驱动以最小化电磁干扰和能量损耗，同时也提供多重保护特性，包括集成欠压闭锁、过流保护、温度检测和故障报告。
  XNS30S73E6 Optimized Gate Drive of the Built-in IGBTs to Minimize EMI and Losses, while also Providing Multiple Protection Features Including Under-voltage Lockouts, Over-current Shutdown, Thermal Monitoring, Fault Reporting.
- XNS30S73E6内置高速HVIC，提供无光耦单电源IGBT栅极驱动能力，进一步减小了逆变器系统设计的总体尺寸。
  XNS30S73E6 Combines High Speed HVIC Provides Opto-Coupler-Less Single-Supply IGBT Gate Driving Capability that Further Reduce the Overall Size of the Inverter System Design.
- 独立的IGBT负端在每个相位均有效，可支持大量不同种类的控制算法。
  Separate Negative IGBT Terminals are Available for Each Phase to Support the Widest Variety of Control Algorithms.

主要特点

- 600V-30 A三相IGBT逆变器，包含栅极驱动和保护的控制IC
- 低损耗、短路额定的IGBT
- 内置带限流电阻的自举二极管
- 低端IGBT的独立发射极开路引脚用于三相电流感测
- 内置温度检测功能
- DBC DIP25封装
- 绝缘级别1500V_{rms}/1min
- 单接地电源供电
- 无铅工艺；符合ROHS

Features

- 600V-30A 3-Phase IGBT Inverter Bridge Including Control ICs for Gate Driving and Protection
- Low-Loss, Short-Circuit Rated IGBTs
- Built-In Bootstrap Diodes with Current Limiting Resistor
- Separate Open-Emitter Pins from Low-Side IGBTs for Three-Phase Current Sensing
- Built-In Temperature Sensor
- DBC DIP25 Package
- Isolation Rating: 1500 V_{rms}/min
- Single-Grounded Power Supply
- Lead-free Terminal Plating; RoHS Compliant

应用

- 运动控制 – 家用设备 / 工业电机

Applications

- Motion Control – Home Appliance / Industrial Motor

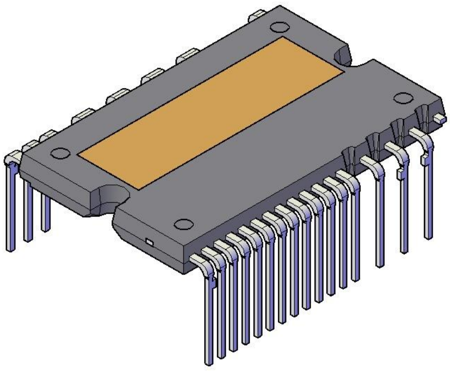

图1. 封装概览

Figure1. Package Overview

绝对最大额定值 / Absolute Maximum Ratings

逆变器部分(单个IGBT，除非另有说明) / Inverter Part (Each IGBT ® Unless Otherwise Specified)

符号/Symbol	参数/Parameter	工作条件/ Conditions	额定值/Rating	单位/Unit
V_{PN}	加在P-N之间的电源电压 DC Link Input Voltage		450	V
$V_{PN(Surge)}$	加在P-N之间的电源浪涌电压 DC Link Input Voltage Surge		500	
V_{CES}	集电极-发射极之间电压 Collector-Emitter Voltage		600	
$\pm I_C$	单个IGBT集电极电流 Each IGBT Collector Current	T_C= 25°C, T_J≤100°C	30	A
$\pm I_{CP}$	单个IGBT集电极峰值电流 Each IGBT Collector Peak Current	T_C= 25°C, T_J≤100°C , PW < 1ms	60	
P_C	最大功耗 Maximum Power Dissipation	T_C=25°C, 单个芯片/Per one chip	80	W
T_J	工作结温 Operating Junction Temperature		-40~150	°C

控制部分/ Control Part

符号/Symbol	参数/Parameter	工作条件/ Conditions	额定值/Rating	单位/Unit
V_D	控制电源电压 Control Supply Voltage	施加在V_{P1}-V_{NC}, V_{N1}-V_{NC}之间 Applied Between V_{P1}-V_{NC}, V_{N1}-V_{NC}	20	V
V_{DB}	高端偏置电压 High-side Bias Voltage	施加在V_{UFB}-V_{UFS}, V_{VFB}-V_{VFS}, V_{WFB}-V_{WFS}之间 Applied Between V_{UFB}-V_{UFS}, V_{VFB}-V_{VFS}, V_{WFB}-V_{WFS}	20	
V_{IN}	输入信号电压 Input Signal Voltage	施加在IN和V_{NC}之间 Applied Between IN and V_{NC}	- 1.0~ 15	
V_{FO}	故障输出电源电压 Fault Output Supply Voltage	施加在V_{FO}和V_{NC}之间 Applied Between V_{FO} and V_{NC}	- 1.0~7	
I_{FO}	故障输出电流 Fault Output Current	V_{FO}引脚处的灌电流 Sink Current at V_{FO} Pin	10	mA
V_{SC}	电流感测输入电压 Current Sensing Input Voltage	施加在CIN和V_{NC}之间 Applied Between CIN and V_{NC}	- 1.0~ 20	V

热阻 / Thermal Resistance

符号/Symbol	参数/Parameter	工作条件/ Conditions	额定值/Rating	单位/Unit
$R_{th(j-c)Q}$	节点-壳体热阻（注1） Junction to Case Thermal Resistance (Note1)	逆变器工作条件下的单个IGBT Each IGBT under Inverter Operating Condition	1.5	°C /W
$R_{th(j-c)F}$		逆变器工作条件下的单个FRD Each FRD under Inverter Operating Condition (Note 1)	2.0	

注 / Note 1.关于壳体温度（T_C）的测量点，参见图2。 / For the Measurement Point of Case Temperature T_C, Please refer to Figure 2.

整个系统 / Total System

符号/Symbol	参数/Parameter	工作条件/ Conditions	额定值/Rating	单位/Unit
$V_{PN(PROT)}$	自我保护电源电压限制 Self Protection 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 Case Operation Temperature	-40°C≤T_J≤ 150°C	-40 ~ 125	°C
T_{STG}	存储温度 Storage Temperature		-40 ~ 125	
V_{ISO}	绝缘电压 Isolation Voltage	60Hz，正弦波，1分钟，连接基板到引脚 60 Hz, Sinusoidal, 1 minute, Connection Pins to Heatsink	1500	V_{rms}

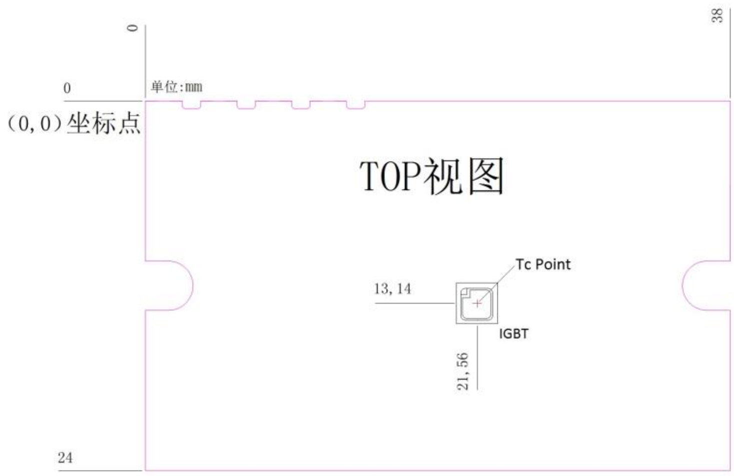

图2. 壳温测量点

Figure2. Tc Measurement Position

引脚描述 / Pin descriptions

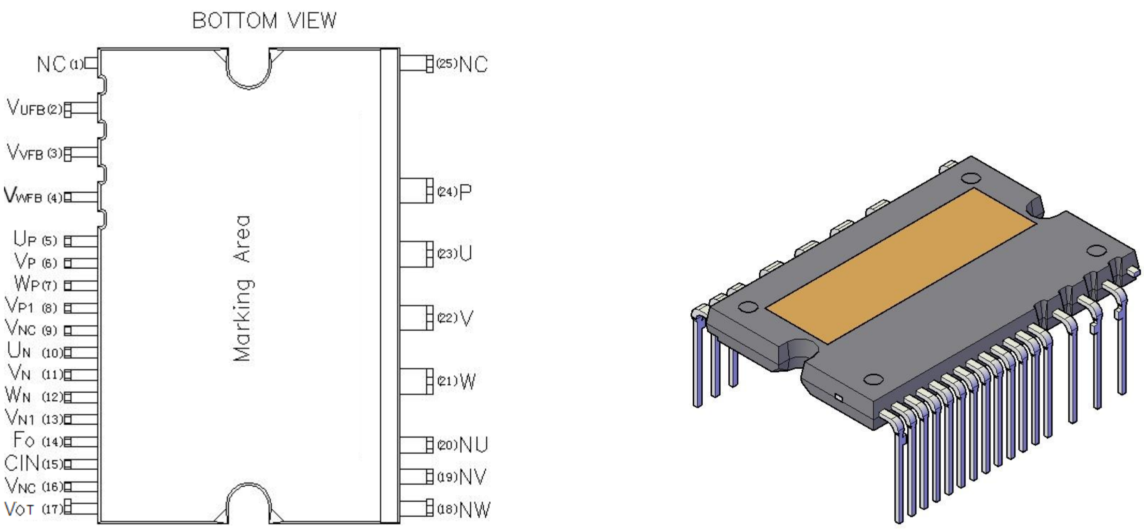

图3. 引脚布局（仰视图）

Figure3. Pin Configuration (Bottom View)

引脚号/Pin Number	引脚名/Pin Name	引脚描述/Pin Description
1	NC	No connection 空引脚
2	VUFB	High-Side Bias Voltage for U-Phase IGBT Driving 上桥臂U相驱动正端
3	VVFB	High-Side Bias Voltage for V-Phase IGBT Driving 上桥臂V相驱动正端
4	VWFB	High-Side Bias Voltage for W-Phase IGBT Driving 上桥臂W相驱动正端
5	UP	Signal Input for High-Side U Phase 上半桥U相逻辑输入端
6	VP	Signal Input for High-Side V Phase 上半桥V相逻辑输入端
7	WP	Signal Input for High-Side W Phase 上半桥W相逻辑输入端
8	VP1	Common Bias Voltage for IC and IGBTs Driver 控制电源正端
9	VNC	Common Supply Ground 下桥臂参考地端
10	UN	Signal Input for Low-Side U Phase 下桥臂U相逻辑输入端
11	VN	Signal Input for Low-Side V Phase 下桥臂V相逻辑输入端
12	WN	Signal Input for Low-Side W Phase 下桥臂W相逻辑输入端
13	VN1	Common Bias Voltage for IC and IGBTs Driver 控制电源正端
14	FO	Fault Output 故障信号输出端
15	CIN	Capacitor for Short-Circuit Current Detector Input 过流电流保护电压检测端
16	VNC	Common Supply Ground 下桥臂参考地端
17	VOT	温度输出脚 Temperature Output Voltage
18	NW	Negative DC-Link Input for W-Phase 逆变器直流电源负端（W相）
19	NV	Negative DC-Link Input for V-Phase 逆变器直流电源负端（V相）
20	NU	Negative DC-Link Input for U-Phase 逆变器直流电源负端（U相）
21	W	Output for W-Phase 逆变器W相输出端
22	V	Output for V-Phase 逆变器V相输出端
23	U	Output for U-Phase 逆变器U相输出端
24	P	Positive DC-Link Input 逆变器直流电压正端
25	NC	N.C 空引脚

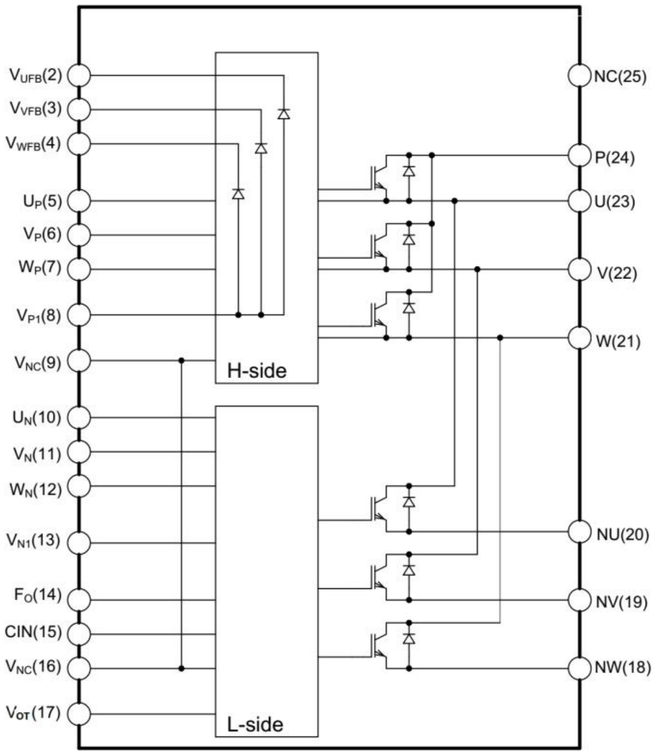

图4. 引脚布局和内部框图（仰视图）

Figure4. Pin Configuration and Internal Block Diagram (Bottom View)

电气特性(T_J= 25°C, V_{CC}=V_{BS}= 15 V，除非另有说明) / Electrical Characteristics (T_J= 25°C, V_{CC}=V_{BS}= 15 V Unless Otherwise Specified)

逆变器部分(单个IGBT，除非另有说明) / Inverter Part(Each IGBT Unless Otherwise Specified)

符号/Symbol		参数/Parameter	工作条件/ Conditions		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, V_{IN}=5V	I_C=30A, T_J=25°C,	-	2.0	2.2	V
				I_C=30A, T_J=125°C,	-	2.2	2.4	
V_{EC}		FWD正向电压 FWD Forward Voltage	V_{IN}= 0V, I_C=-30A,		-	2.4	2.6	
I_{CES}		集电极-发射极间漏电流 Collector-Emitter Leakage Current	V_{CE}=V_{CES}	T_J=25°C,	-	-	0.1	mA
				T_J=125°C,	-	-	1	
HS	t_{ON}	开关参数 Switching Parameters	V_{PN}= 400 V, V_D= V_{DB}= 15 V, I_C=30 A V_{IN}= 0 V ↔5 V, 电感负载 / Inductive Load			660		ns
	$T_{C(ON)}$					300		
	t_{OFF}					860		
	$T_{C(OFF)}$					150		
	t_{rr}					100		
	E_{on}					700		uJ
	E_{off}					600		
LS	t_{ON}					660		ns
	$T_{C(ON)}$					300		
	t_{OFF}					860		
	$T_{C(OFF)}$					150		
	t_{rr}					100		
	E_{on}					1200		uJ
	E_{off}					700		

控制部分/ Control Part

符号/Symbol	参数/Parameter	工作条件/ Conditions		最小值 /Min	典型值 /Typ	最大值 /Max	单位 /Unit
I_P	V_P静态电流 Quiescent V_D Current	V_P=15 V, V_{IN}=0V	施加在V_P和V_{NC}之间 Applied Between V_P and V_{NC}	-	500	800	uA
I_{PB}	V_{PB}静态电流 Quiescent V_{DB} Current	N_{PB}=15 V, V_{IN}=0V	施加在V_{UFB}-V_{UFS}, V_{VFB}-V_{VFS}, V_{WFB}-V_{WFS}; Applied Between V_{UFB}-V_{UFS}, V_{VFB}-V_{VFS}, V_{WFB}-V_{WFS}	-	125	170	
I_N	V_N静态电流 Quiescent V_D Current	V_N=15 V, V_{IN}=0V	施加在V_N和V_{NC}之间 Applied Between V_N and V_{NC}	-	700	900	
V_{FOH}	故障输出电压 Fault Output Voltage	V_{SC}=0V, V_{FO}电路：10KΩ至5V上拉		4.9	-	-	V
V_{FOL}		V_{SC}=1V, I_{FO}=1mA		-	-	0.95	
$V_{SC(ref)}$	Short Circuit Trip Level 短路电流触发电平	V_D=15V (注2/Note2)(图7)(Figure 7)		0.46	0.51	0.56	
I_{IN}	Input Current 输入脚电流	V_{IN}=5V		80	150	200	uA
T_{FO}	CIN到FO延迟时间 Propagation Delay CIN to FO	V_{CIN}=2V		240	320	410	
UV_{PD}	HVIC低端欠压保护（图7） HVIC Low-Side Undervoltage Protection (Figure7)	V_P欠压保护检测电平 V_P Undervoltage Protection Detection Level		9.6	10.1	10.6	V
UV_{PR}		V_P欠压保护复位电平 V_P Undervoltage Protection Reset Level		11.0	11.5	12	
UV_{PBD}	HVIC高端欠压保护（图8） HVIC High-Side Undervoltage Protection (Figure 8)	V_{PB}欠压保护检测电平 V_{PB} Undervoltage Protection Detection Level		9.1	10	10.9	
UV_{PBR}		V_{PB}欠压保护复位电平 V_{PB} Undervoltage Protection Reset Level		10.1	11	11.9	
UV_{ND}	LVIC低端欠压保护（图7） LVIC Low-Side Undervoltage Protection (Figure 7)	V_N欠压保护检测电平 V_N Undervoltage Protection Detection Level		9	10.3	11	
UV_{NR}		V_N欠压保护复位电平 V_N Undervoltage Protection Reset Level		10.4	11.6	12.4	
t_{FOD}	故障输出脉宽 Fault Output Pulse Width			-	24	-	us
V_{IH}	导通阈值电压 ON Threshold Voltage	逻辑高电平 Logic High Level	施加在V_{IN}和V_{NC}之间 Applied between IN and V_{NC}	2.0	2.1	2.2	V
V_{IL}	关断阈值电压 OFF Threshold Voltage	逻辑低电平 Logic Low Level		0.6	0.7	0.8	
R_{BSD}	串联电阻 Resistance			-	150	-	Ω
V_{OT}	Temperature Output Voltage 温度输出电压	T_J= 25°C		0.974	1.16	1.345	V

注 / Note 2.短路电流保护仅作用于低端。 / Short-Circuit Current Protection is Functioning Only at the Low-Side.

推荐工作条件 / Recommended Operating Condition

符号/Symbol	参数/Parameter	工作条件/ Conditions	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 Applied Between P and N	-	300	400	V
V_D	控制电源电压 Control Supply Voltage	施加在V_D和V_{NC}之间 Applied Between V_D and V_{NC}	13.5	15	16.5	
V_{DB}	高端偏压 High-Side Bias Voltage	施加在V_{UFB}-V_{UFS}, V_{VFB}-V_{VFS}, V_{WFB}-V_{WFS}; Applied Between V_{UFB}-V_{UFS}, V_{VFB}-V_{VFS}, V_{WFB}-V_{WFS}	13.5	15	16.5	V
dV_D/d_t, dV_{DBS}/d_t	控制电源波动 Control Supply Variation		-1	-	1	V/us
t_{dead}	防止桥臂直通的死区时间 Blanking Time for Preventing Arm-Short	每个输入信号/For Each Input Signal	1	-	-	us
f_{PWM}	PWM开关频率 PWM Switching Frequency	-40°C≤T_C ≤ 100°C , -40°C≤T_J ≤ 125°C	-	-	20	kHz
V_{SEN}	电流感测产生的电压 Voltage for Current Sensing	施加在N_U, N_V, N_W – V_{NC}之间（包括浪涌电压） Applied between N_U, N_V, N_W – V_{NC}(Including Surge Voltage)	-5	-	5	V
T_J	工作结温 Operating Junction Temperature		-40	-	150	°C

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

参数/Parameter	工作条件/ Conditions		最小值 /Min	典型值 /Typ	最大值 /Max	单位 /Unit
安装扭矩 Mounting Torque	安装螺钉：M3 Mounting Screw: M3	建议0.78 N.m Recommended 0.78 N.m	0.59	0.69	0.78	N.m
器件平面度 Device Flatness		见图4 See Figure 4	-50	-	100	um
重量 Weight			-	7	-	g

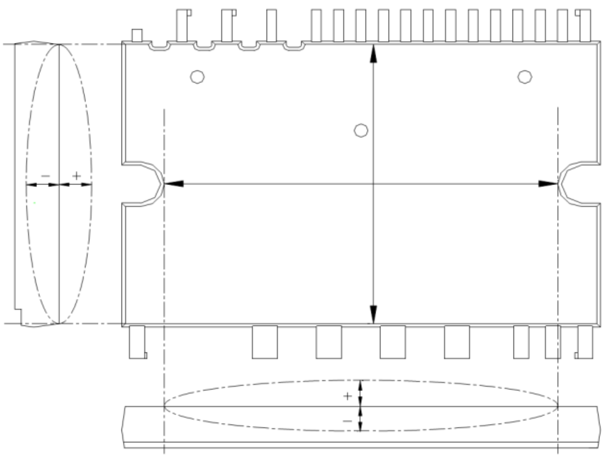

图5. 平面度测量位置

Figure5. Flatness Measurement Position

功能时序图 / Time Charts Function

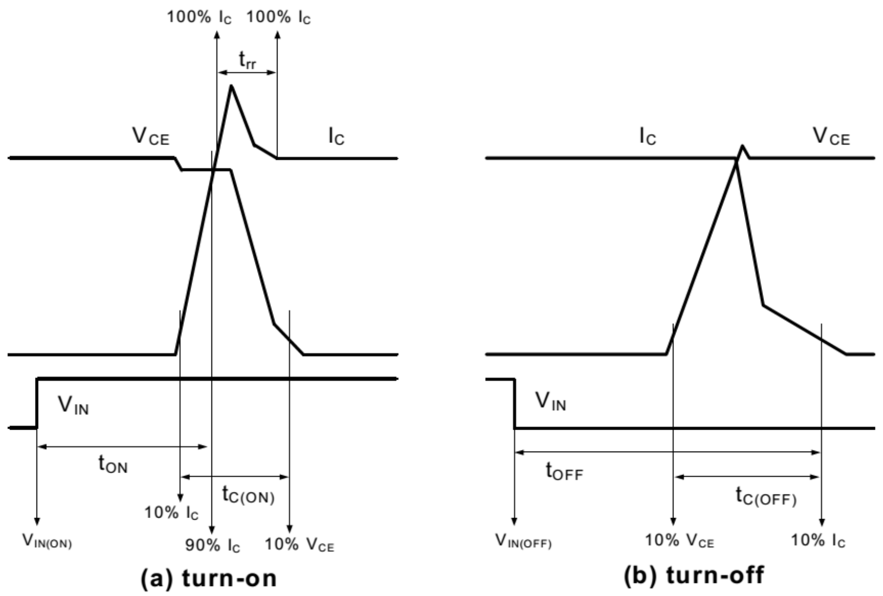

图6. 开关时间定义

Figure6. Switching Time Definition

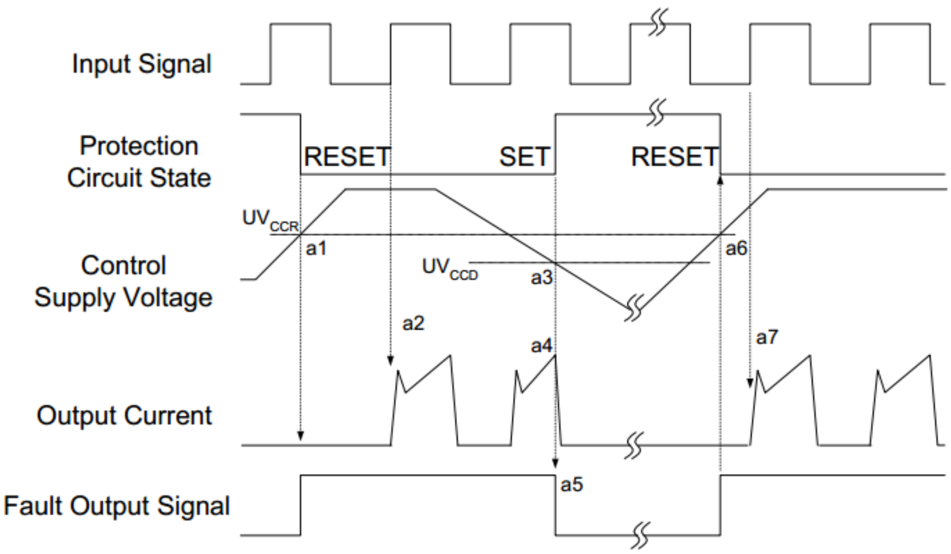

图7. 欠压保护（低端）

Figure7. Undervoltage Protection (Low-side)

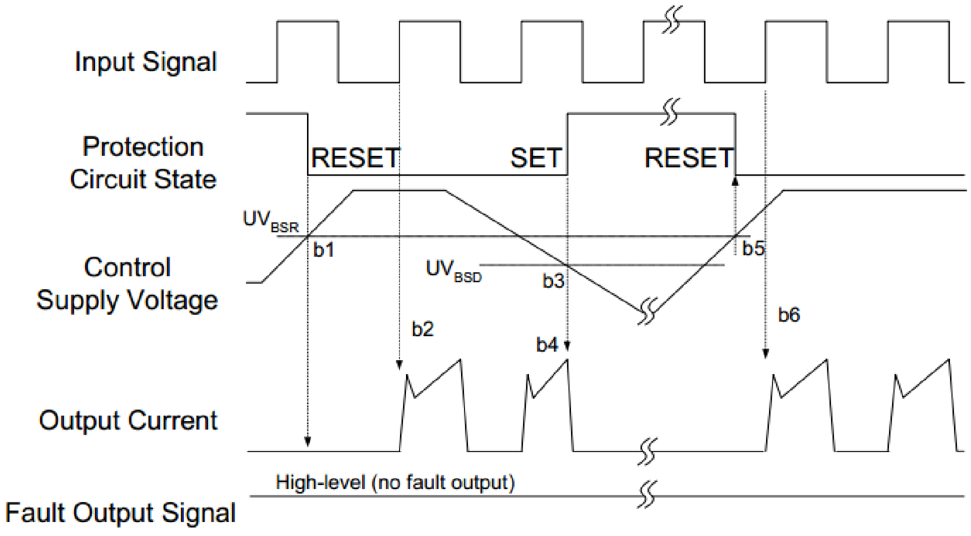

图8. 欠压保护（高端）

Figure8. Undervoltage Protection (High-side)

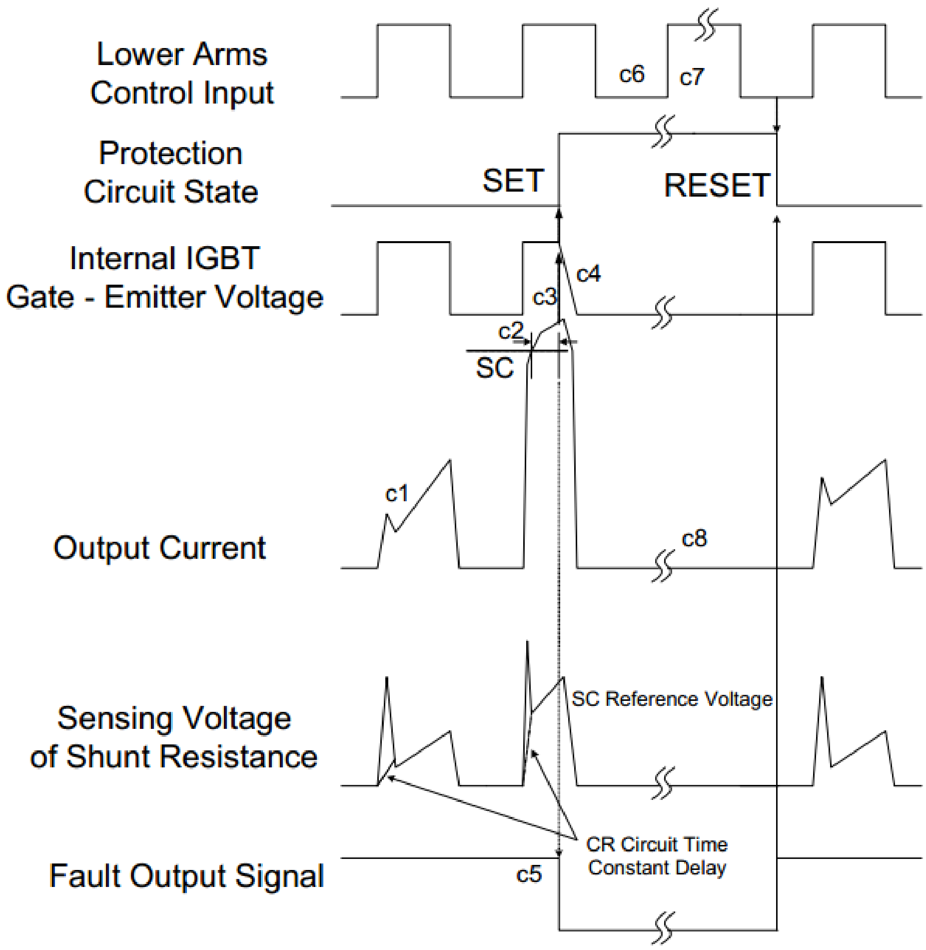

图9. 短路电流保护（低端）

Figure9. Short-circuit Current Protection (Low-side)

推荐应用电路 / Recommended Application Circuit

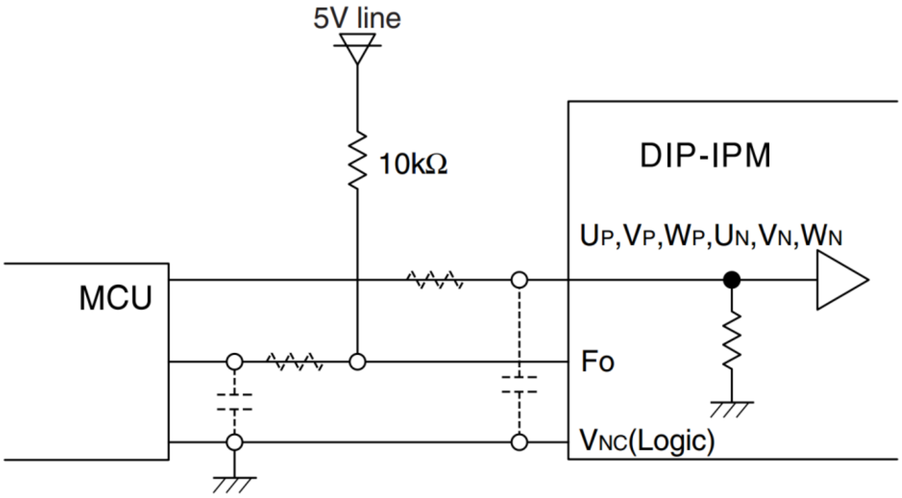

图10. 推荐的MCU接口

Figure10. Recommended MCU Interface and Bootstrap Circuit with Parameters

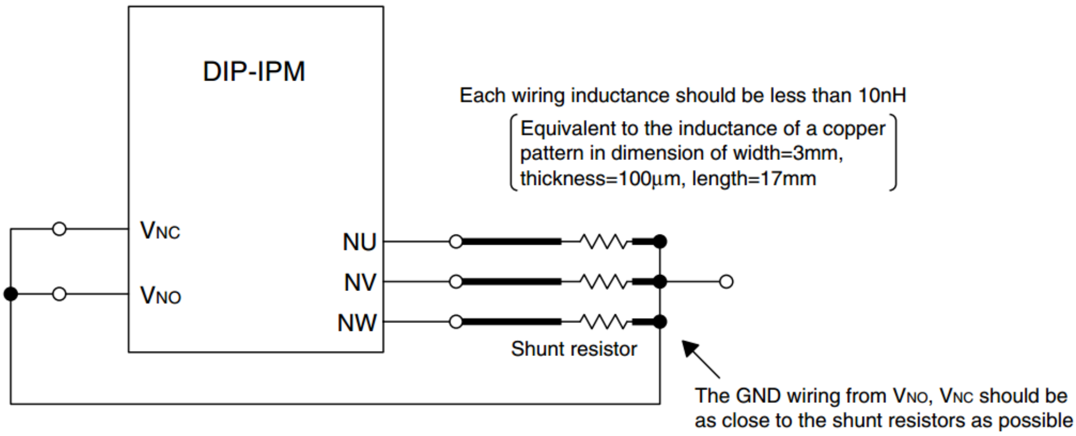

图11. 推荐的分流电阻布线

Figure11. Recommended Wiring Around The Shunt Resistor

图12. 温度输出电压

Figure12. Temperature Output Voltage

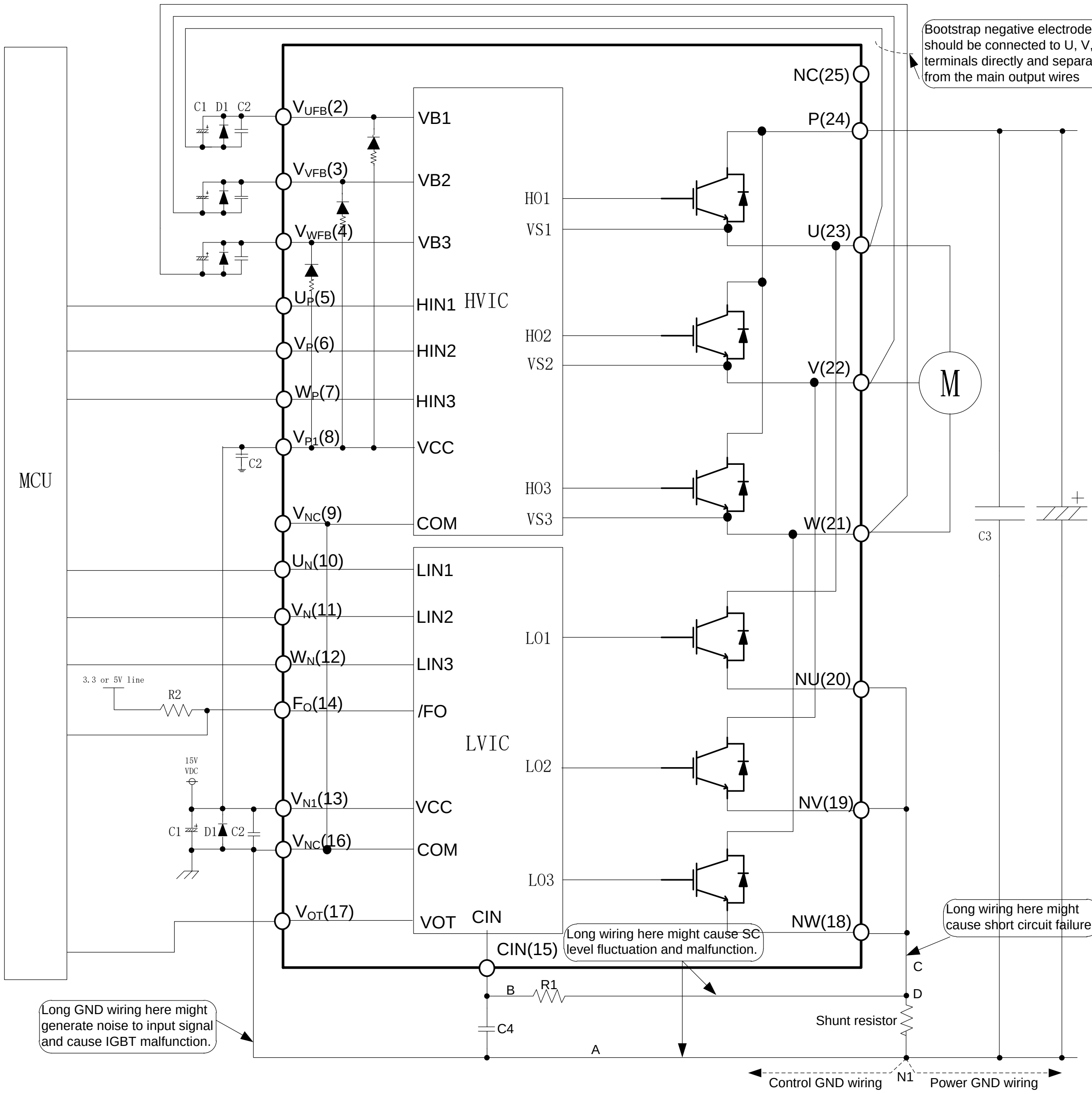

图13. 典型应用电路

Figure13. Typical Application Circuit

注/Note:

1.推荐在电源上加稳压二极管D1（24V/1W），防止浪涌电压损坏IPM。
It is recommended to insert a Zener diode D1 (24V/1W) between each pair of control supply terminals to prevent surge destruction.

2.输入正逻辑，下拉电阻5.4KΩ。为了避免故障，应尽可能缩短每个输入端的连线 （小于2-3 cm）。
Input logic is High-active. There is a 5.4KΩ pull down resistor. To avoid malfunction, the wiring of each input should be as short as possible (less than 2-3cm).

3.为避免保护功能出错，应尽可能缩短R1和C4 周围的连线。
To prevent errors of the protection function, the wiring of B, C and D point should be as short as possible.

4.在短路保护电路中，R1C4 的时间常数应在1.5 ~ 2.0 µs 的范围内进行选择。
In the short-circuit protection circuit, please select the R1C4 time constant in the range 1.5 ~ 2.0 µs.

5.每个电容都应尽可能地靠近产品的引脚安装。（C1：温度特性好，频率特性好；C2：0.22u-2uF，温度特性好，频率特性好）
Each capacitor should be mounted as close to the pins of the product as possible. (C1: good temperature, frequency characteristic electrolytic type and C2: 0.22u-2uF, good temperature, frequency and DC bias characteristic ceramic type are recommended.)

6.为防止浪涌的破坏，应尽可能缩短滤波电容和P & GND 引脚间的连线。推荐在P & GND 引脚间使用0.1 ~ 0.22 µF 的高频无感电容C3。
To prevent surge destruction, the wiring between the smoothing capacitor and the P & GND pins should be as short as possible. The use of a high-frequency non-inductive C3 capacitor of around 0.1 ~ 0.22 µF between the P & GND pins is recommended.

7.在各种家用电器设备中，几乎都用到了继电器。在这些情况下，MCU 和继电器之间应留有足够的距离。
Relays are used at almost every systems of electrical equipments at industrial application. In these cases, there should be sufficient distance between the CPU and the relays.

8.控制地和功率地应该分开布线，相交于一点N1。
It is recommended to connect control GND and power GND at only a point N1 (near the terminal of shunt resistor).

9.为避免误动作，A、B、C布线应尽可能的短。
To prevent malfunction, the wiring of A, B, C should be as short as possible.

10.D点应该靠近分流电阻端。当使用一个分流电阻时，NU, NV, NW三个端子应相互靠近。推荐使用高精度温度系数低的分流电阻。
The point D at which the wiring to C4 filter is divided should be near the terminal of shunt resistor. NU, NV, NW terminals should be connected at near NU, NV, NW terminals when it is used by one shunt operation. Low inductance SMD type with tight tolerance, temp-compensated type is recommended for shunt resistor.

11.FO是集电极开路，需要用电阻上拉到MCU的电源电压（5V或3.3V），I_{FO}电流不得超过1mA。
FO output is open drain type. It should be pulled up to power supply of MCU (e.g. 5V, 3.3V) by a resistor that makes I_{FO} up to 1mA.

12.高频噪声施加在控制电源上会造成IC误动作，导致IPM错误运行。为避免这个问题，控制电压应满足dV/dt≤+/-1V/us, Vripple≤2Vp-p。
If high frequency noise superimposed to the control supply line, IC malfunction might happen and cause DIPIPM erroneous operation. To avoid such problem, line ripple voltage should meet dV/dt≤+/-1V/us, Vripple≤2Vp-p.

轮廓封装详图：单位-毫米 / Detailed Package Outline Drawings: Unit-mm

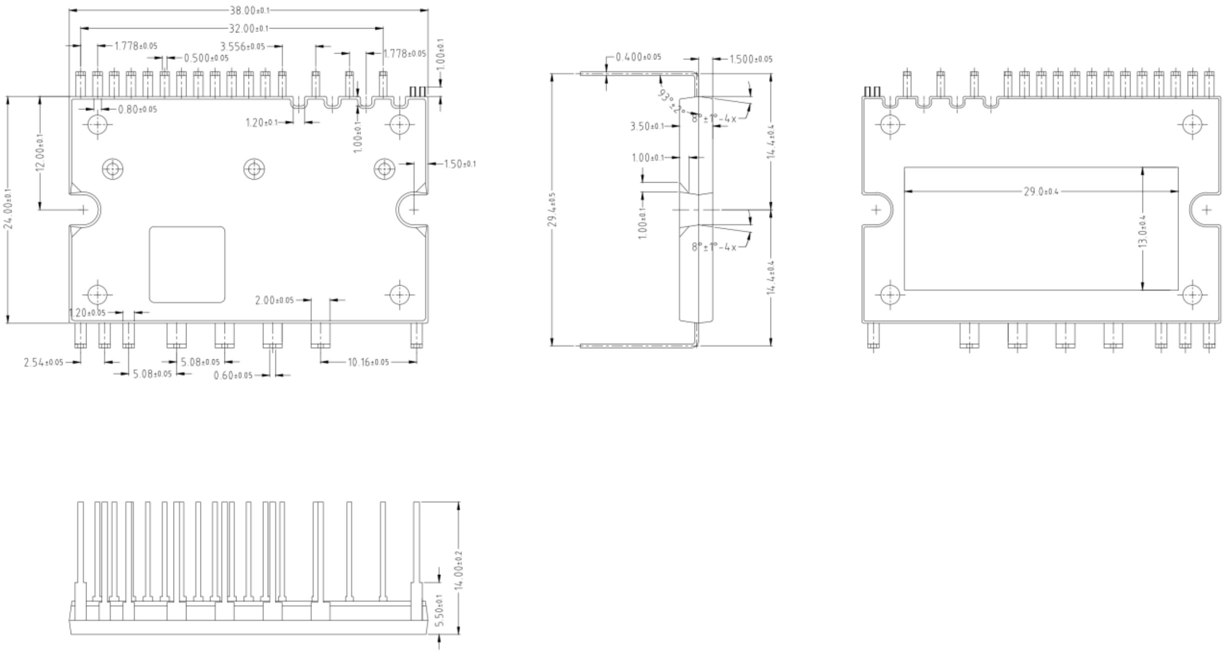

图15. 封装轮廓

Figure15. Package Outline

封装打标和订货信息 / Package Marking & Ordering Information

Device Marking	Device	Package	Packing Type	Quantity
XNS30S73E6	XNS30S73E6	IPM-DIP25	Tube	12

版本历史 /Revision history

Revision	Changes
1.0	初版发布
1.1	修正参数

For technical support, please contact Xiner's Technical Assistance Center
www.invsemi.com

WORLD HEADQUARTERS: