

描述/Description

- XNS1245MF基于Trench FS-IGBT技术，是一款先进的DIP33 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。
XNS1245MF is an Advanced DIP33 IPM Based on Trench FS-IGBT Technology, Providing a Fully-featured, High-performance Inverter Output Stage for AC Induction, BLDC, and PMSM Motors.
- XNS1245MF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、过温保护和故障报告。
XNS1245MF 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, Over-temperature Shutdown, Fault Reporting.
- XNS1245MF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。
XNS1245MF 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-20 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
- 内置过温保护功能
- 背部铜片实现低热阻
- 绝缘级别2500V_{rms}/1min
- 单接地电源供电
- 无铅工艺；符合ROHS

Features

- 600V-20A 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 Over Temperature Protection Function
- Low Thermal Resistance Using Heatsink PAD
- Isolation Rating: 2500 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

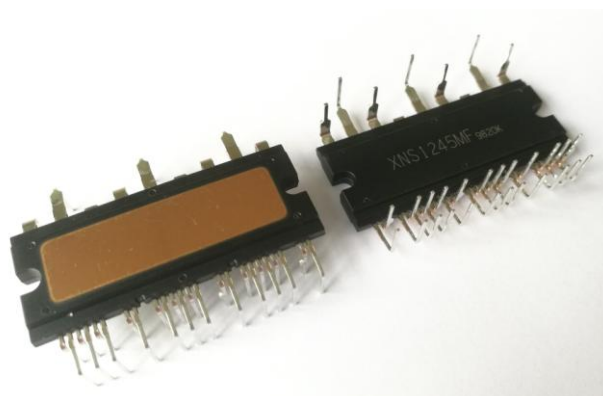


图1. 封装概览

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	
I_C	单个IGBT集电极电流 Each IGBT Collector Current	$T_C = 25^\circ\text{C}, T_J \leq 150^\circ\text{C}$	20	A
I_{CP}	单个IGBT集电极峰值电流 Each IGBT Collector Peak Current	$T_C = 25^\circ\text{C}, T_J \leq 150^\circ\text{C}, PW < 1\text{ms}$	40	
P_C	最大功耗 Maximum Power Dissipation	$T_C = 25^\circ\text{C}$, 单个芯片/Per one chip	50	W
T_J	工作结温 Operating Junction Temperature		-40~150	$^\circ\text{C}$

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_{CC}	控制电源电压 Control Supply Voltage	施加在 V_{CC} -COM之间 Applied Between V_{CC} -COM	25	V
V_{BS}	高端偏置电压 High-side Bias Voltage	施加在 V_{B1} - H_{S1} , V_{B2} - H_{S2} , V_{B3} - H_{S3} 之间 Applied Between V_{B1} - H_{S1} , V_{B2} - H_{S2} , V_{B3} - H_{S3}	25	
V_{IN}	输入信号电压 Input Signal Voltage	施加在IN和COM之间 Applied Between IN and COM	-0.3~25	
V_{FO}	故障输出电源电压 Fault Output Supply Voltage	施加在 V_{FO} 和COM之间 Applied Between V_{FO} and COM	-0.3~25	
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OCP和COM之间 Applied Between OCP and COM	-0.3~25	V

自举二极管部分(单个二极管, 除非另有说明) / Bootstrap Diode Part (Each Bootstrap Diode Unless Otherwise Specified)

符号/Symbol	参数/Parameter	工作条件/ Conditions	额定值/Rating	单位/Unit
V_{RRMB}	最大重复反向电压 Maximum Repetitive Reverse Voltage		600	V
I_{FB}	正向电流 Forward Current	$T_C = 25^\circ\text{C}$	1	A
I_{FPB}	正向电流(峰值) Forward Current (Peak)	$T_C = 25^\circ\text{C}$, Under 1ms Pulse Width	2	A
T_J	工作结温 Operating Junction Temperature		-40~150	$^\circ\text{C}$

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	2.5	$^\circ\text{C}/\text{W}$
$R_{th(j-c)F}$		逆变器工作条件下的单个FRD Each FRD under Inverter Operating Condition (Note 1)	3.5	

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	$V_{CC}=V_{BS}=13.5V\sim 16.5V$, $T_J=125^{\circ}C$, 非重复性, $<2\mu s$	400	V
T_C	模块壳体工作温度 Module Case Operation Temperature	$-40^{\circ}C \leq T_J \leq 150^{\circ}C$	-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	2500	V_{rms}

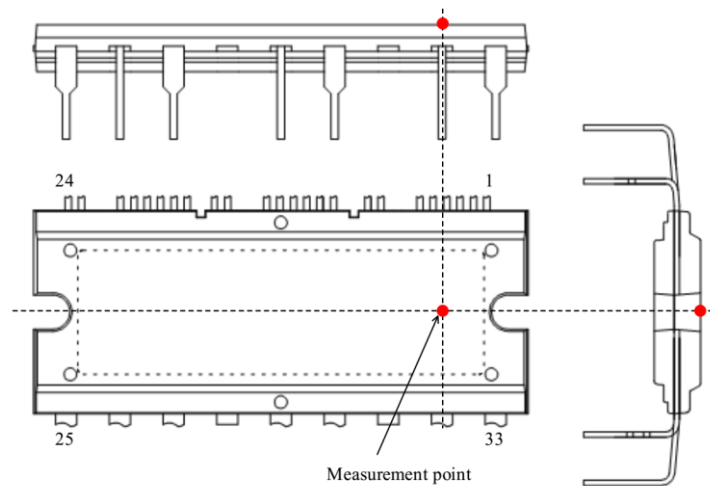


图2. 壳温测量点

Figure2. Tc Measurement Position

引脚描述 / Pin descriptions

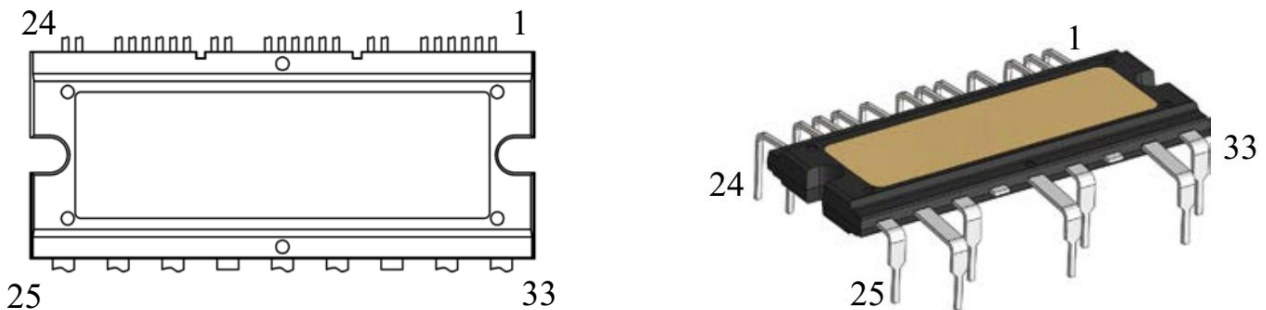


图3. 引脚布局 (俯视图)

Figure3. Pin Configuration (TOP View)

引脚号/Pin Number	引脚名/Pin Name	引脚描述/Pin Description
1	FO1	U-phase Fault Signal Output U相故障信号输出和使能信号输入端
2	OCP1	U-phase Short-Circuit Current Detector Input U相过流电流保护电压检测端
3	LIN1	Signal Input for Low-Side U-phase 下桥臂U相逻辑输入端
4	COM1	U-phase Common Supply Ground U相下桥臂参考地端
5	HIN1	Signal Input for High-Side U-phase 上半桥U相逻辑输入端
6	VCC1	U-phase Common Bias Voltage for IC and IGBTs Driver U相控制电源正端
7	VB1	High-Side Bias Voltage for U-phase IGBT Driving U相IGBT驱动的高端偏压
8	HS1	High-Side Bias Voltage Ground for U-phase IGBT Driving U相IGBT驱动的高端偏压的地
9	FO2	V-phase Fault Signal Output V相故障信号输出和使能信号输入端
10	OCP2	V-phase Short-Circuit Current Detector Input V相过流电流保护电压检测端
11	LIN2	Signal Input for Low-Side V-phase 下桥臂V相逻辑输入端
12	COM2	V-phase Common Supply Ground V相下桥臂参考地端
13	HIN2	Signal Input for High-Side V-phase 上半桥V相逻辑输入端
14	VCC2	V-phase Common Bias Voltage for IC and IGBTs Driver V相控制电源正端
15	VB2	High-Side Bias Voltage for V-phase IGBT Driving V相IGBT驱动的高端偏压
16	HS2	High-Side Bias Voltage Ground for V-phase IGBT Driving V相IGBT驱动的高端偏压的地
17	FO3	W-phase Fault Signal Output W相故障信号输出和使能信号输入端
18	OCP3	W-phase Short-Circuit Current Detector Input W相过流电流保护电压检测端
19	LIN3	Signal Input for Low-Side W-phase 下桥臂W相逻辑输入端
20	COM3	W-phase Common Supply Ground W相下桥臂参考地端
21	HIN3	Signal Input for High-Side W-phase 上半桥W相逻辑输入端
22	VCC3	W-phase Common Bias Voltage for IC and IGBTs Driver W相控制电源正端
23	VB3	High-Side Bias Voltage for W-phase IGBT Driving W相IGBT驱动的高端偏压
24	HS3	High-Side Bias Voltage Ground for W-phase IGBT Driving W相IGBT驱动的高端偏压的地
25	VBB	Positive DC-Link Input 直流正端
26	W	Output for W-phase W相输出
27	LS3	Negative DC-Link Input for W-phase W相的直流环节负极
28	VBB	Positive DC-Link Input 直流正端
29	V	Output for V-phase V相输出
30	LS2	Negative DC-Link Input for V-phase V相的直流环节负极
31	VBB	Positive DC-Link Input 直流正端
32	U	Output for U-phase U相输出
33	LS1	Negative DC-Link Input for U-phase U相的直流环节负极

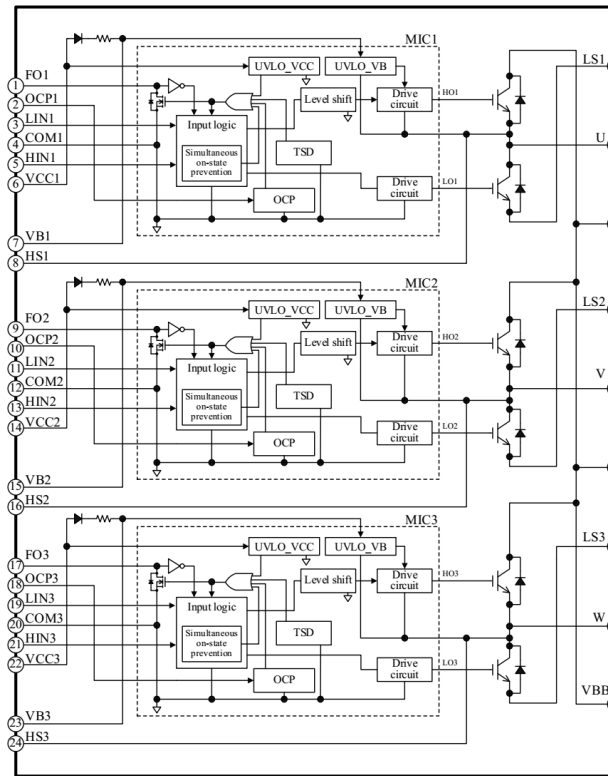


图4. 引脚布局和内部框图（俯视图）

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

电气特性 ($T_J = 25^\circ\text{C}$, $V_{CC} = V_{BS} = 15\text{V}$, 除非另有说明) / Electrical Characteristics ($T_J = 25^\circ\text{C}$, $V_{CC} = V_{BS} = 15\text{V}$ 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	$V_{CC} = V_{BS} = 15\text{V}$, $V_{IN} = 5\text{V}$	$I_C = 20\text{A}$, $T_J = 25^\circ\text{C}$, $I_C = 20\text{A}$, $T_J = 150^\circ\text{C}$,	-	1.7	1.9	V
V_{EC}	FWD正向电压 FWD Forward Voltage	$V_{IN} = 0\text{V}$, $I_C = -20\text{A}$,		-	1.8	2.0	
I_{CES}	集电极-发射极间漏电流 Collector-Emitter Leakage Current	$V_{CE} = V_{CES}$	$T_J = 25^\circ\text{C}$, $T_J = 150^\circ\text{C}$,	-	-	0.1	mA
				-	-	1	
HS	t_{ON}	开关参数 Switching Parameters	$V_{PN} = 400\text{V}$, $V_{CC} = V_{BS} = 15\text{V}$, $I_C = 20\text{A}$ $V_{IN} = 0\text{V} \leftrightarrow 5\text{V}$, 电感负载 /Inductive Load	-	700	900	ns
	$T_{C(ON)}$			-	250	350	
	t_{OFF}			-	1500	1800	
	$T_{C(OFF)}$			-	250	350	
	t_{rr}			-	50	100	
	E_{on}			-	1000	-	
LS	t_{ON}			-	750	950	ns
	$T_{C(ON)}$			-	250	350	
	t_{OFF}			-	1500	1800	
	$T_{C(OFF)}$			-	250	350	
	t_{rr}			-	50	100	
	E_{on}			-	1000	-	
	E_{off}	-	1000	-	uJ		

控制部分(单个IC, 除非另有说明) / Control Part(Each IC 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
I_{QCC}	V_{CC} 静态电流 Quiescent V_{CC} Current	$V_{CC}=15V$, $V_{IN}=0V$	施加在 V_{CC} 和COM之间 Applied Between V_{CC} and COM	-	0.75	1.0	mA
I_{QBS}	V_{BS} 静态电流 Quiescent V_{BS} Current	$V_{BS}=15V$, $V_{IN}=0V$	施加在 $V_{B1-H_{S1}}$, $V_{B2-H_{S2}}$, $V_{B3-H_{S3}}$; Applied Between $V_{B1-H_{S1}}$, $V_{B2-H_{S2}}$, $V_{B3-H_{S3}}$	-	100	150	uA
V_{FOH}	故障输出电压 Fault Output Voltage	$V_{SC}=0V$, V_{FO} 电路: 10K Ω 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	$V_{CC}=15V$ (注2/Note2)(图9)(Figure 9)		0.45	0.5	0.55	
I_{IN}	Input Current 输入脚电流	$V_{IN}=5V$		-	0.3	0.4	mA
t_{FILIN}	输入HIN1, HIN2, HIN3, LIN1, LIN2, LIN3 滤波时间; Input Filter Time at HIN1, HIN2, HIN3, LIN1, LIN2, LIN	$V_{SC}=0V$, $V_{IN}=0\&5V$		200	300	400	ns
DT	死区时间 Dead Time			400	500	600	
T_{OCP}	保护关断延迟时间 Shutdown Propagation Delay			2000	2800	3500	
T_{BK}	OCP输入滤波 Blanking Time	$V_{SC}=2V$		1000	1600	2000	
T_{FO}	OCP到FO延迟时间 Propagation Delay OCP to FO			1200	1700	2200	
UV_{CCD}	低端欠压保护 (图7) Low-Side Undervoltage Protection (Figure 5)	V_{CC} 欠压保护检测电平 V_{CC} Undervoltage Protection Detection Level		10.6	11.3	12.0	V
UV_{CCR}		V_{CC} 欠压保护复位电平 V_{CC} Undervoltage Protection Reset Level		11.0	11.7	12.4	
UV_{BSD}	高端欠压保护 (图8) High-Side Undervoltage Protection (Figure 6)	V_{BS} 欠压保护检测电平 V_{BS} Undervoltage Protection Detection Level		10.4	11.1	11.8	
UV_{BSR}		V_{BS} 欠压保护复位电平 V_{BS} Undervoltage Protection Reset Level		10.9	11.6	12.3	
T_{DH}	保护温度 OTP Operating Temperature	$V_{CC}=15V$		135	150	-	°C
T_{DL}	恢复温度 OTP Releasing Temperature			105	120	-	
t_{FOD}	故障输出脉宽 Fault Output Pulse Width			20	25	-	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COM之间 Applied between IN and COM	1.6	2.0	2.4	V
V_{IL}	关断阈值电压 OFF Threshold Voltage	逻辑低电平 Logic Low Level		1.1	1.5	1.9	

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.

自举二极管部分(单个二极管, 除非另有说明) / Bootstrap Diode Part(Each Bootstrap Diode 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_{FB}	正向电压 Forward Voltage	$I_f=0.1A$, $T_c=25^\circ C$ $I_f=0.1A$, $T_c=25^\circ C$		-	4.5	-	V
t_{rrB}	反向恢复时间 Reverse Recovery Time	$I_f=0.1A$, $T_c=25^\circ C$		-	80	-	ns
R_{BSD}	串联电阻 Resistance between VF=4V and 10V	$V_{F1}=4V$, $V_{F2}=10V$		20	30	40	Ω

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_{CC}	控制电源电压 Control Supply Voltage	施加在 V_{CC} 和COM之间 Applied Between V_{CC} and COM	14	16	18.5	
V_{BS}	高端偏压 High-Side Bias Voltage	施加在 V_{B1-HS1} , V_{B2-HS2} , V_{B3-HS3} ; Applied Between V_{B1-HS1} , V_{B2-HS2} , V_{B3-HS3}	13.5	-	18.5	V
d_{VCC}/d_t , d_{VBS}/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	$-40^{\circ}\text{C} \leq T_c \leq 100^{\circ}\text{C}$, $-40^{\circ}\text{C} \leq T_j \leq 125^{\circ}\text{C}$	-	-	20	kHz
V_{SEN}	电流感测产生的电压 Voltage for Current Sensing	施加在LS1, LS2, LS3 – COM之间 (包括浪涌电压) ; Applied between LS1, LS2, LS3 – COM (Including Surge Voltage)	-5	-	5	V
T_j	工作结温 Operating Junction Temperature		-40	-	150	$^{\circ}\text{C}$

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 5	0	-	200	um
重量 Weight			-	11.8	-	g

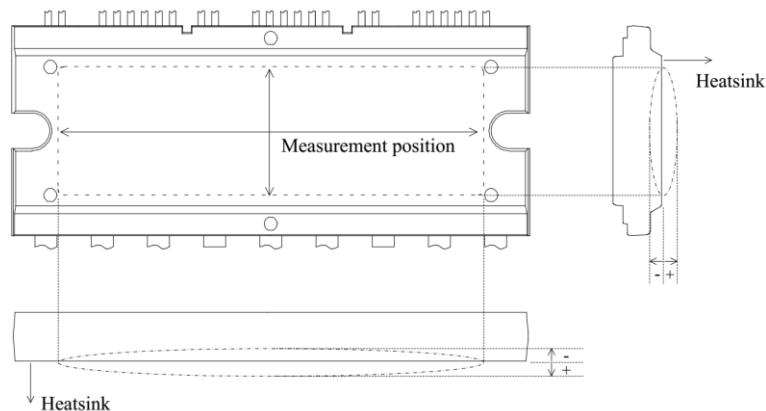


图5. 平面度测量位置

Figure5. Flatness Measurement Position

功能时序图 / Time Charts Function

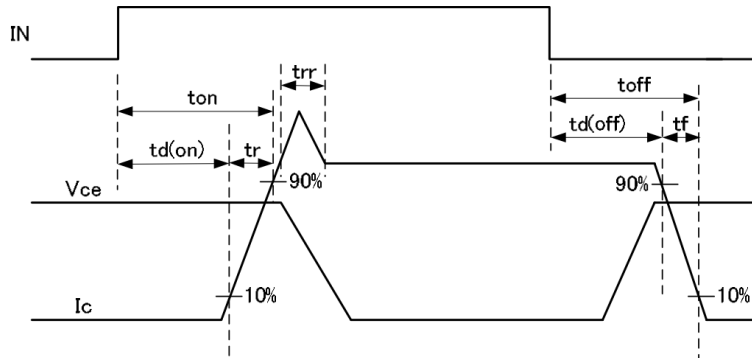


图6. 开关时间定义

Figure6. Switching Time Definition

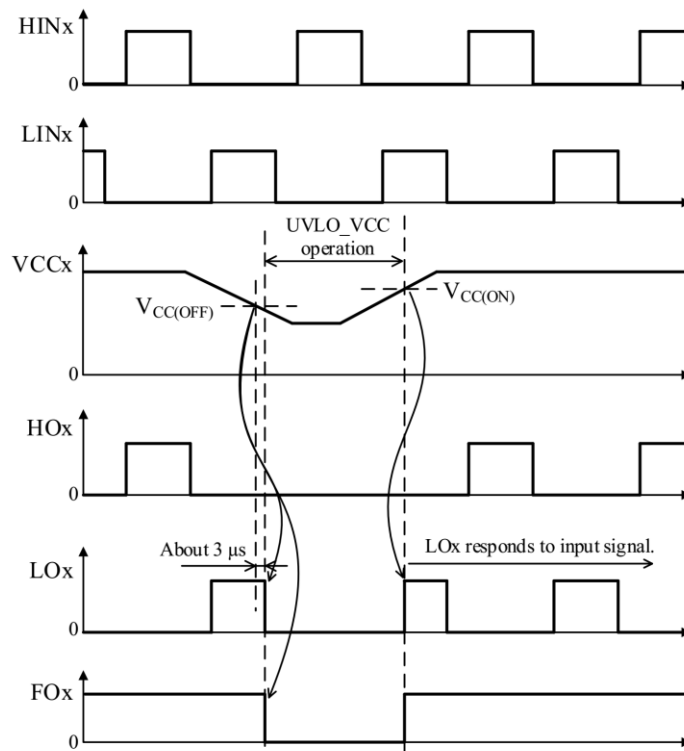


图7. 欠压保护（低端）

Figure7. Undervoltage Protection (Low-side)

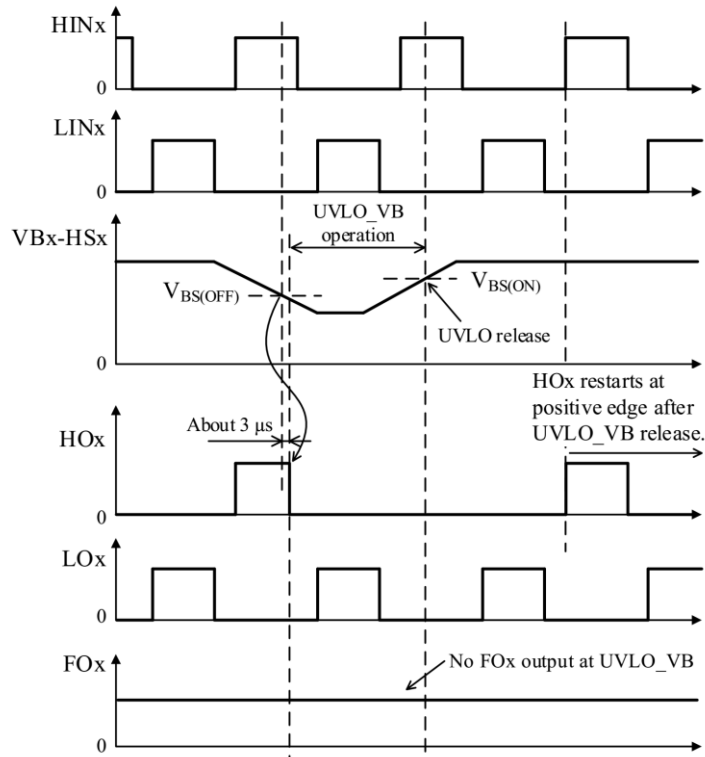


图8. 欠压保护 (高端)

Figure8. Undervoltage Protection (High-side)

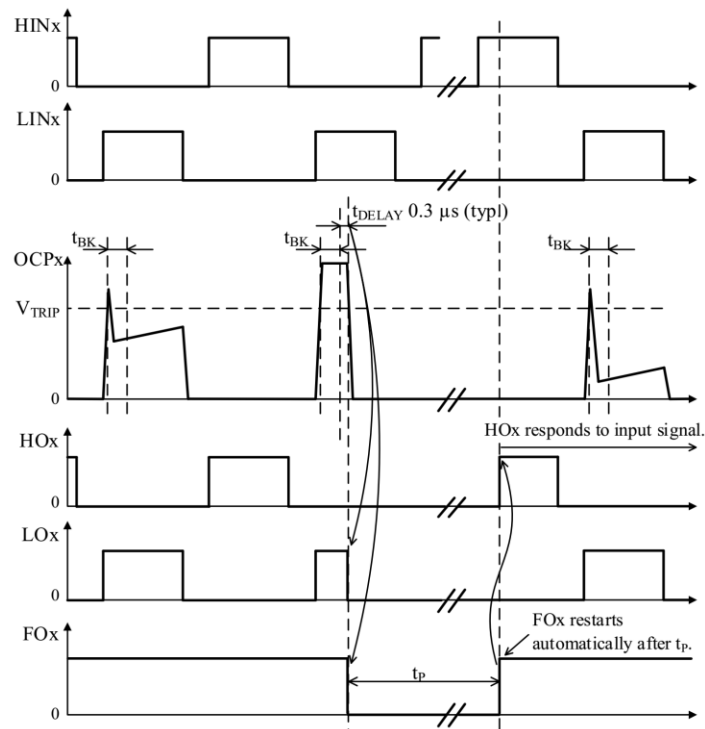


图9. 短路电流保护 (低端)

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

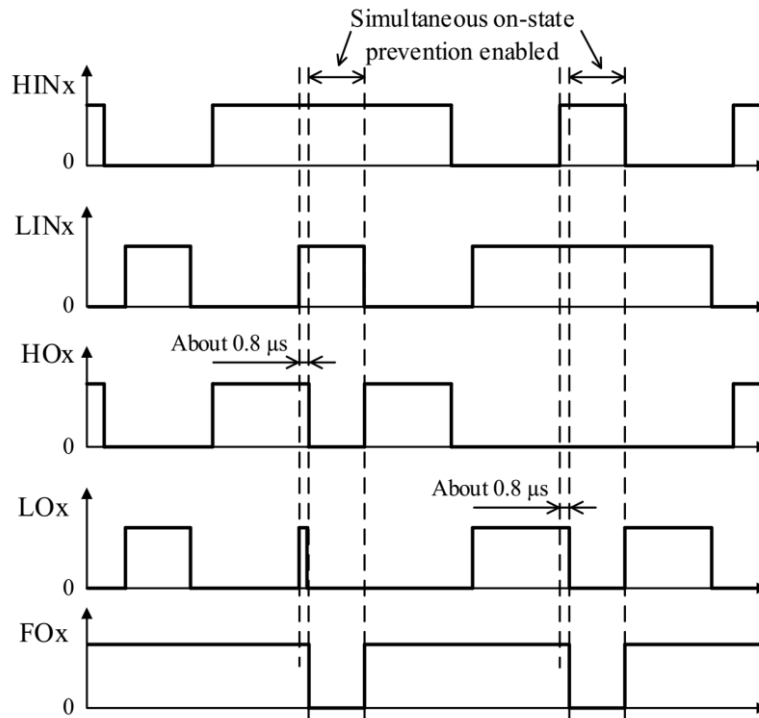


图10. 防直通功能

Figure10.On-state Prevention Waveforms

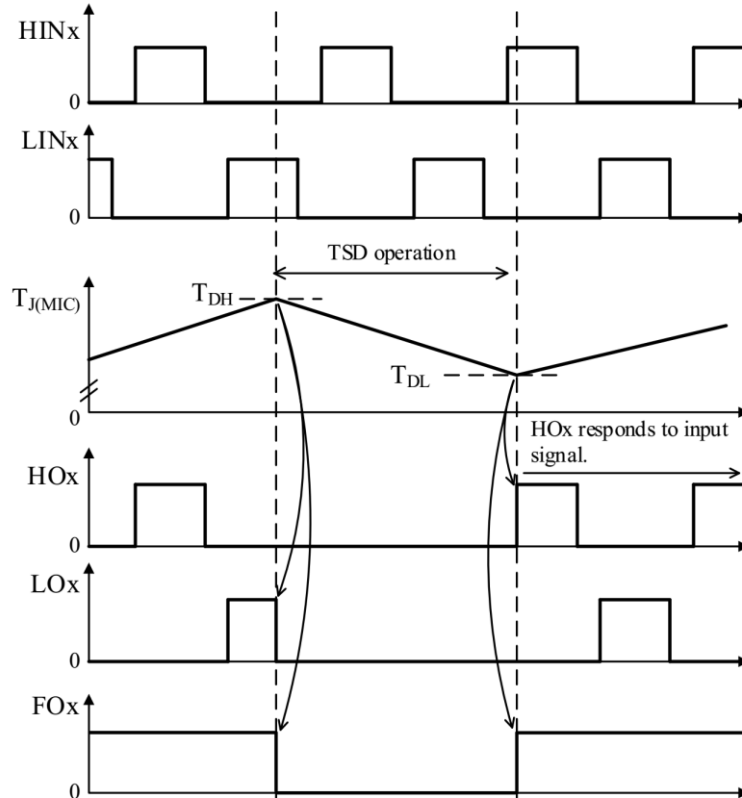


图11. 过温保护功能

Figure11. Over Temperature Protection Waveforms

推荐应用电路 / Recommended Application Circuit

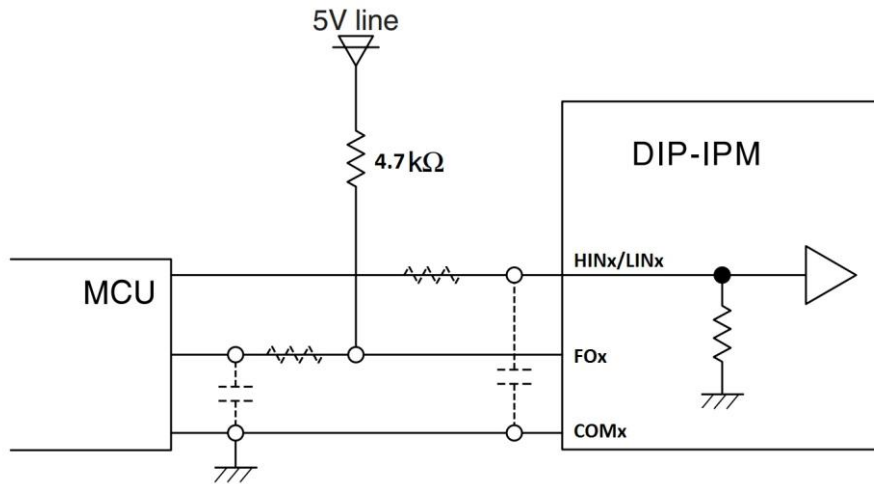


图12. 推荐的MCU接口

Figure12. Recommended MCU Interface and Bootstrap Circuit with Parameters

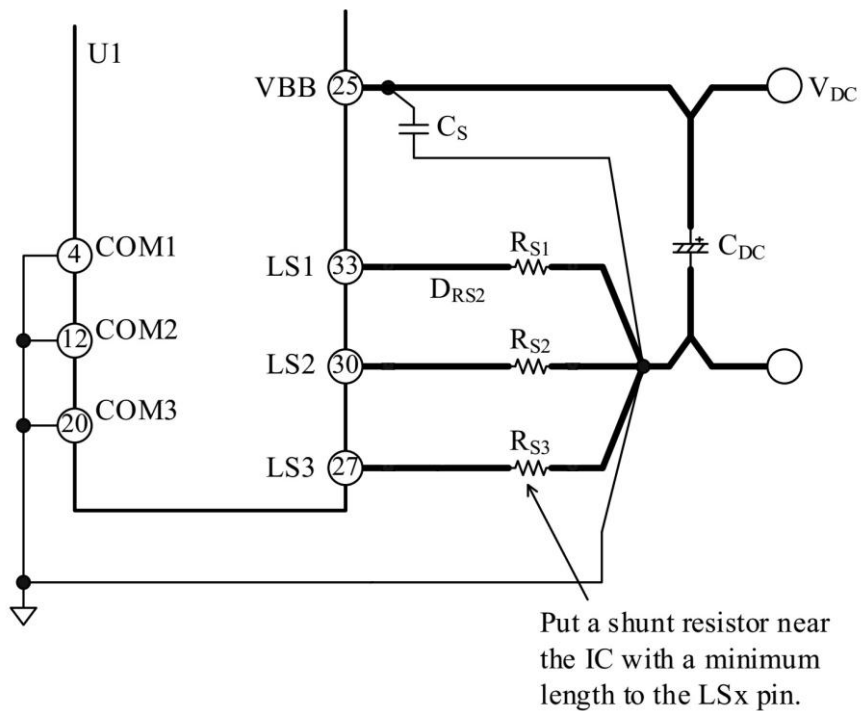


图13. 推荐的分流电阻布线

Figure13. Recommended Wiring Around The Shunt Resistor

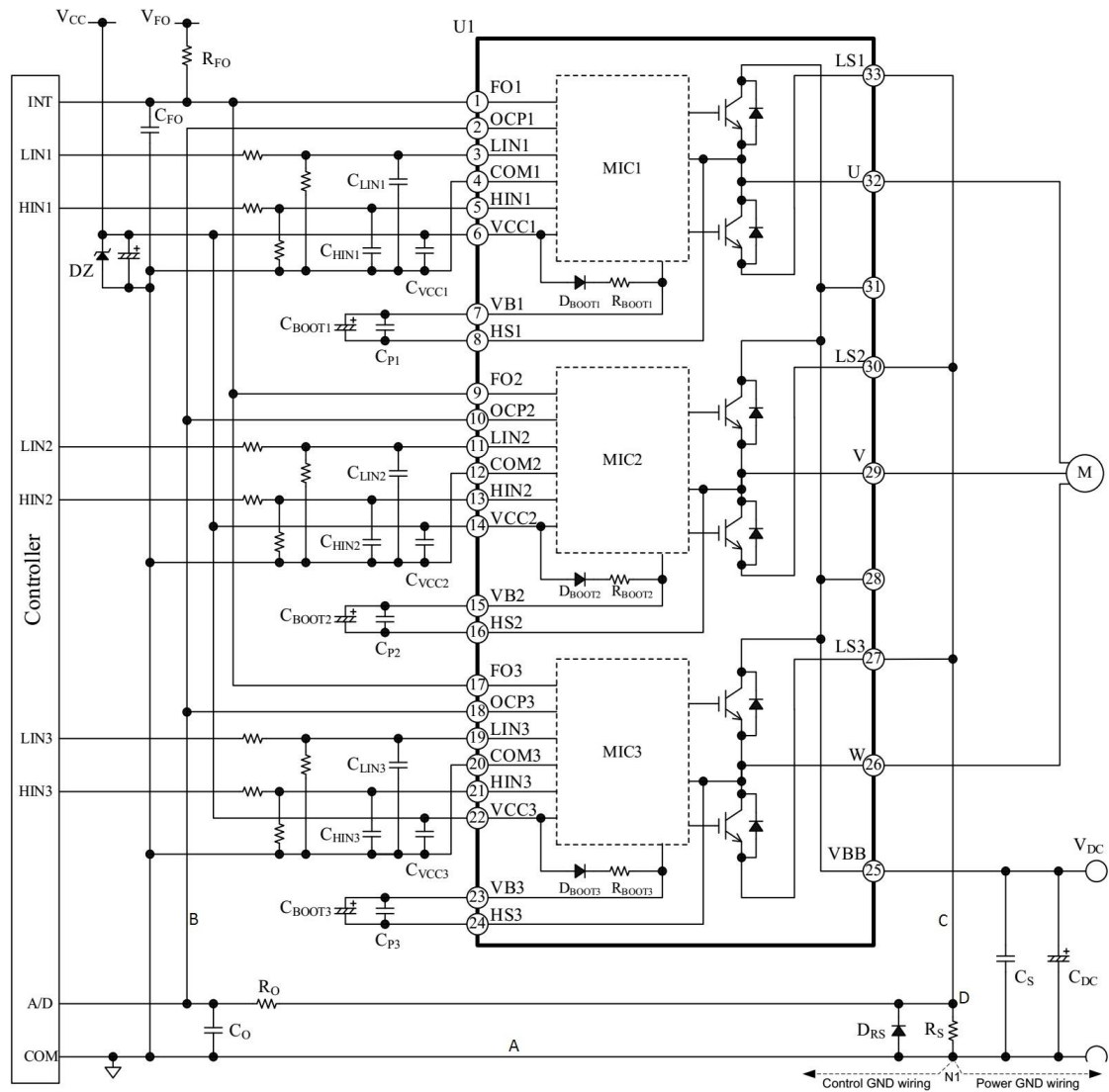


图14. 典型应用电路

Figure14. Typical Application Circuit

注/Note:

1. 推荐在电源上加稳压二极管DZ (24V/1W)，防止浪涌电压损坏IPM。
It is recommended to insert a Zener diode DZ (24V/1W) between each pair of control supply terminals to prevent surge destruction.
2. 输入正逻辑，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. 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RO和CO 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，ROCO 的时间常数应在 $\leq 0.22 \mu s$ 的范围内进行选择。
In the short-circuit protection circuit, please select the ROCO time constant in the range $\leq 0.22 \mu s$.
5. 每个电容都应尽可能地靠近产品的引脚安装。
Each capacitor should be mounted as close to the pins of the product as possible.
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Cs。
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 Cs 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，LS1, LS2, LS3三个端子应相互靠近。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 C0 filter is divided should be near the terminal of shunt resistor. LS1, LS2, LS3 terminals should be connected at near LS1, LS2, LS3 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10mA。
 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 10mA.
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 $dV/dt \leq +/-1V/\mu s$, $V_{ripple} \leq 2V_{p-p}$ 。
 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 $dV/dt \leq +/-1V/\mu s$, $V_{ripple} \leq 2V_{p-p}$.

轮廓封装详图 / Detailed Package Outline Drawings

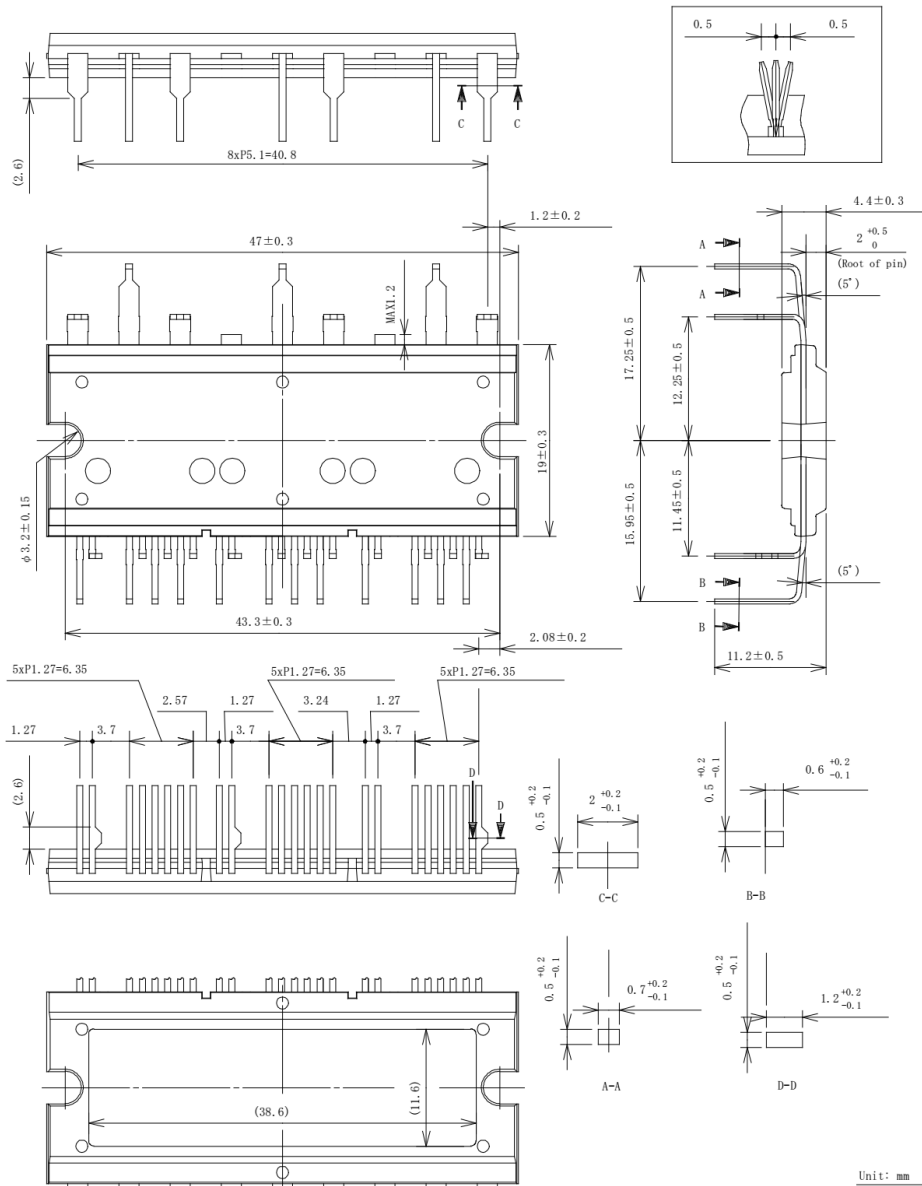


图15. 封装轮廓

Figure15. Package Outline

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

Device Marking	Device	Package	Reel Size	Packing Type	Quantity
XNS1245MF	XNS1245MF	IPM-DIP33	-	RAIL	10

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