FOR ENERGY EFFICIENT INNOVATIONS

THINK ON.

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工业驱动和服务器方案

许宾

现场应用经理

高性能IGBT、智能功率模块(IPM)和功率集成模块(PIM)助力工业驱动控制

IGBT产品聚焦客户需求

- ✓ 中国劳动力成本不断升高 09-17CAGR = 11.6%
- ✓ 智能化无人化工业应用 3.0 & 4.0

- ✓ ErP stage 3 (EMEA)
- ✓ GB18613 (China)
- ✓ FER (NA)
- ✓ IEC Grade IE1~IE34 (EMEA/NA)

- ✓ 电动汽车助力“零排放”
- ✓ 2025年燃油车退出计划

- ✓ 2018年到2022年车用和工业功率模块需求的高复合增长率 = 12.5%
- ✓ 2018年目标市场超过14亿美金

- ✓ 中国过去五年劳动力减少了三百多万
- ✓ 出生率和预测的出生率不断降低

- ✓ 污染物颗粒
- ✓ 全球大气排放污染t

目标应用：注重汽车/工业市场

❑ ON IGBT产品聚焦高可靠性的汽车应用/大功率工业应用

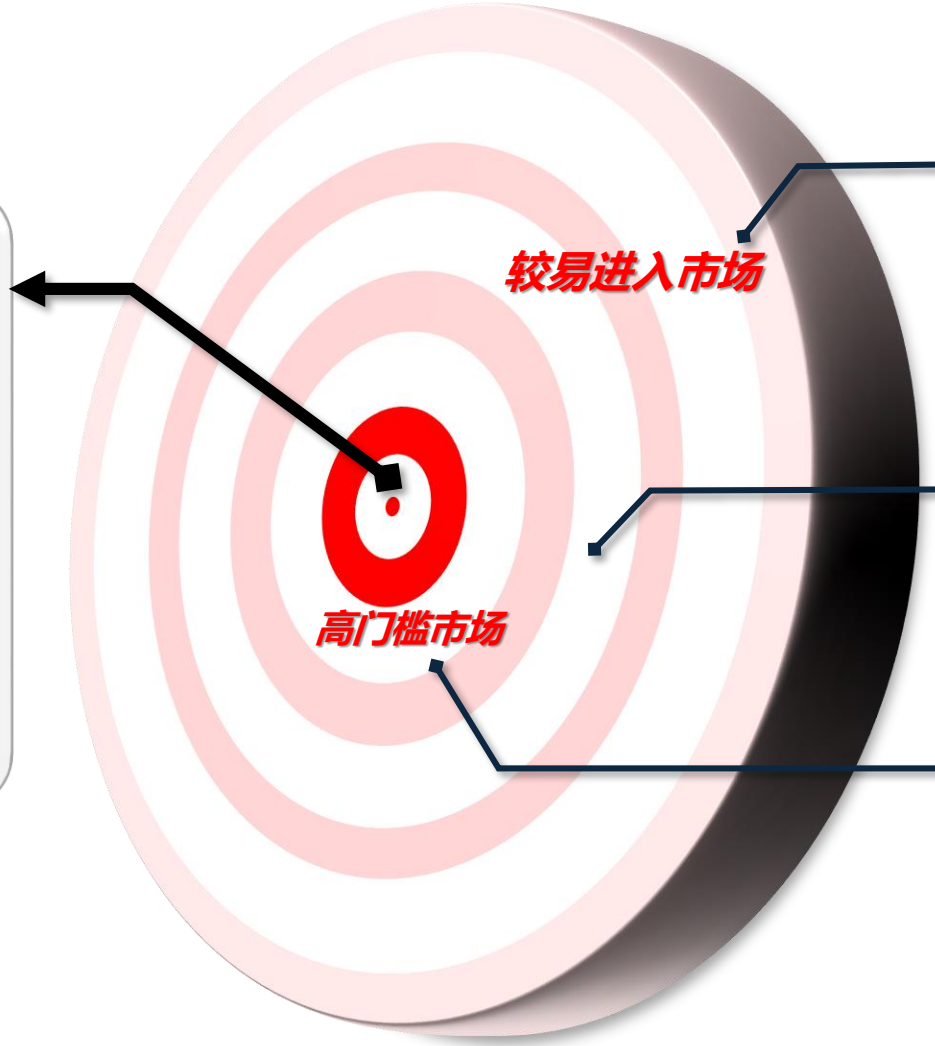
新兴市场！

汽车

-车用压缩机
-牵引力控制
-高压风扇 / 泵
-超级快充

大功率工业应用

-工业机器人
-私服驱动
-高功率变频空调
-高功率泵



市场份额

家用电器 *最大份额
-冰箱
-空调
-洗碗碟机
-洗衣机
-风扇电机

小功率工业应用 *最大份额
- 循环泵
- 工业风扇

大功率空调 主要份额
-2~3HP 式 A/C
- 商业 A/C
-暖通空调(HVAC)

*2018 Quantity base

安森美半导体IGBT系列产品 – 全球化运作

菲利克斯, 美国
总部 & 市场部

格雷沙姆， 美国
高压驱动IC晶圆厂

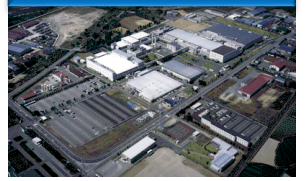
苏州, 中国
封测

- *封测*
- *晶圆*
- *设计*

仁川, 韩国
设计
功率器件晶圆厂

新泻, 日本
IGBT
快恢晶圆厂

会津, 日本
IGBT晶元厂



群马，日本
设计

波特兰, 美国
高压驱动晶圆厂

捷克
IGBT晶圆厂

芙蓉市， 马来西亚
晶圆测试

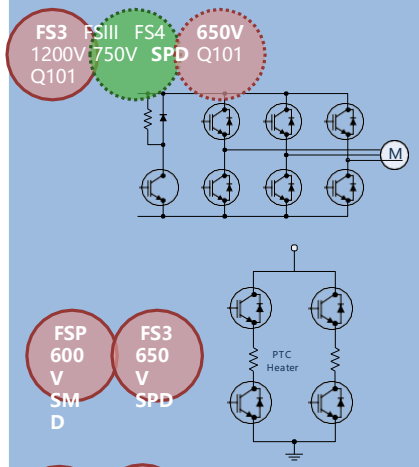
胡志明， 越南
封测

宿务, 菲律宾
封测

包含工业驱动控制在内的工业和汽车应用拓扑

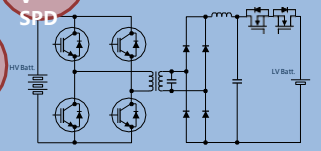
汽车

FS3 1200V Q101 | FSIII 750V | FS4 SPD | 650V Q101



FSP 600 V SMD | FS3 650 V SPD

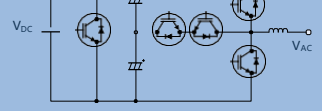
FS4 650 V Q101 | FS3 650 V SPD | FSP 600 V SMD



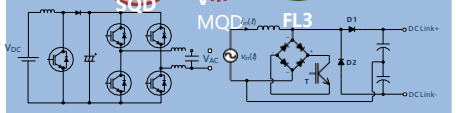
太阳能/ 不间断电源 / 储能

FS4 650V SQD | FS4 950V SQD | FS4 650V LQD | FS4 950V LQD | 650V MQD

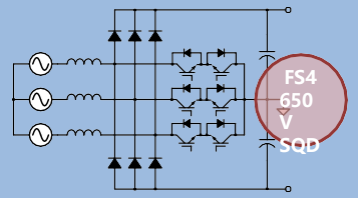
FS4 650 V SQD | FS4 650V *LQD | UFS 1200 V FL3

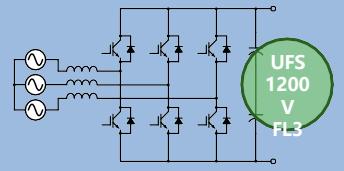


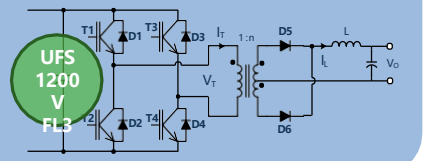
FS4 650 V SQD | FS4 650V MQD | UFS 1200 V FL3



充电桩

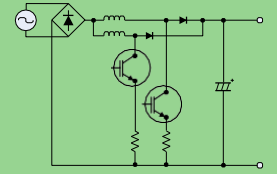






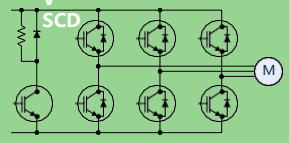
工业驱动控制

FS3 650 V ADF | FSII 600V T1/T2 | FS4 650 V RC

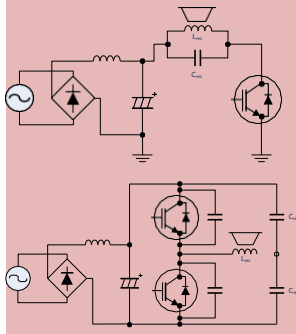


RCII 600 V SCR | FSII 600V | FSII 1200 V FL2 | FL2

NPT 600V UQDF | FS3 650 V SCD



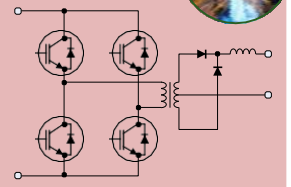
工业加热



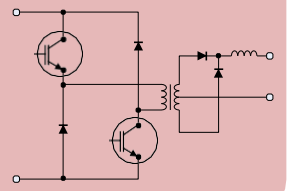
UFS 1400 V IHR | FS4 650 V UQD | FSII 650 V IHR | FS4 650V

电焊机

FS3 650 V WDF | FS3 1200 V UFS 1200 V FL3



FS3 650 V | FS3 650 V SH

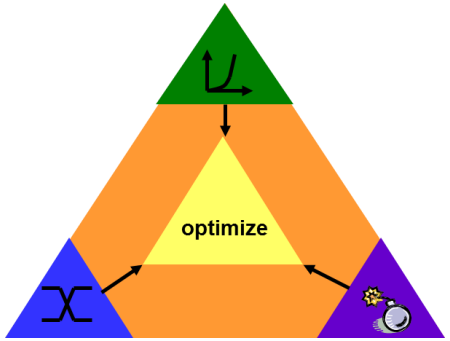


IGBT根据性能要求权衡设计

三角平衡设计

Vce(饱和压降)

- 导通损耗 (V)



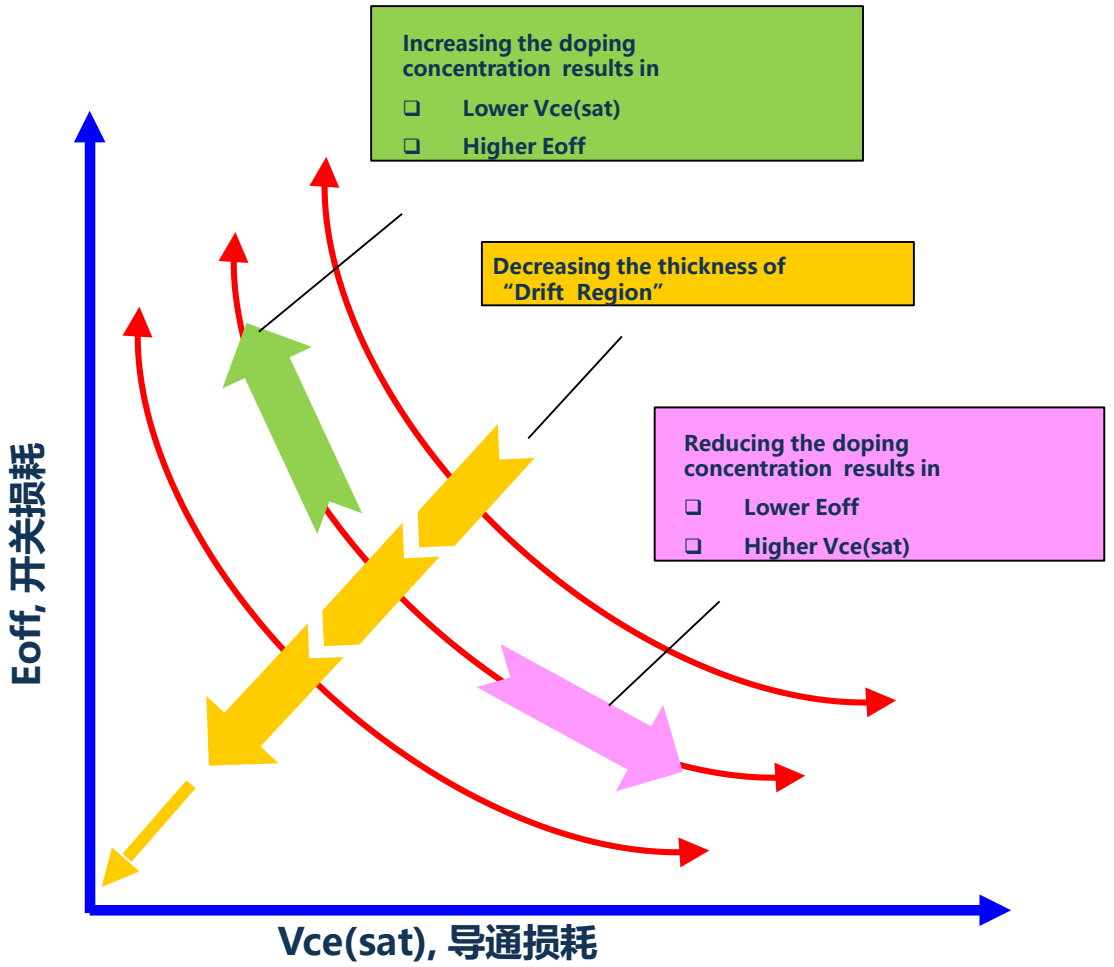
开关性能

- 关断损耗

抗冲击能力

- 短路耐受能力

权衡设计

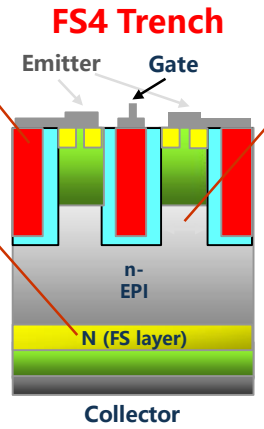


安森美半导体最新一代IGBT工艺介绍

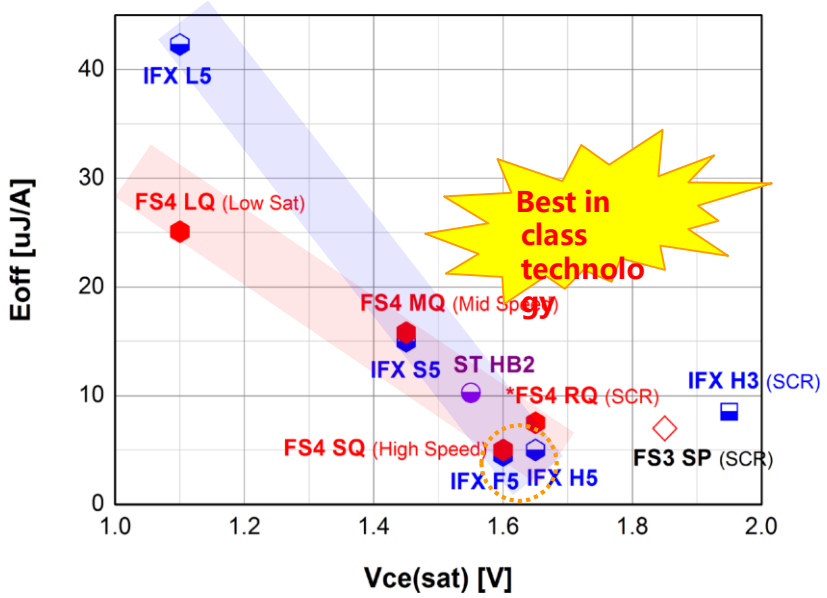
- 650V / 750V / 950V IGBTs

Emitter Trench
Lower Qg

Implanted Buffer
Robust FS layer, Gradual turn-off wave form

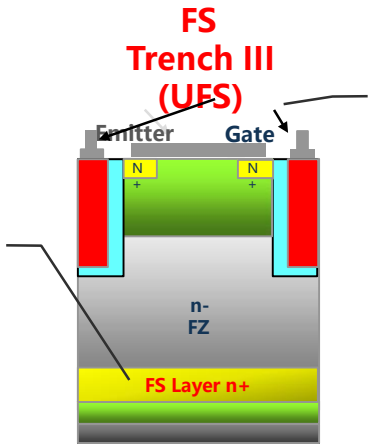


Fine Cell pitch
Higher power density

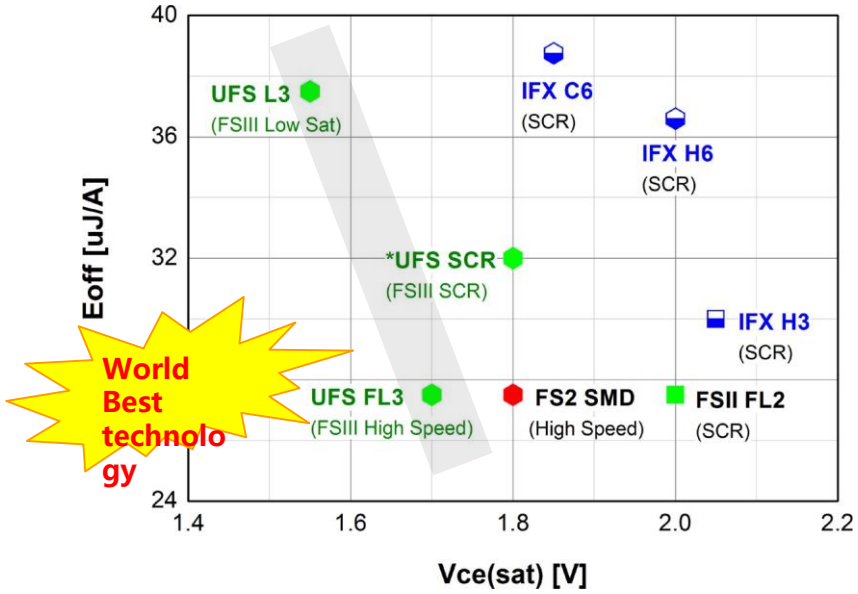


- 1200V IGBTs

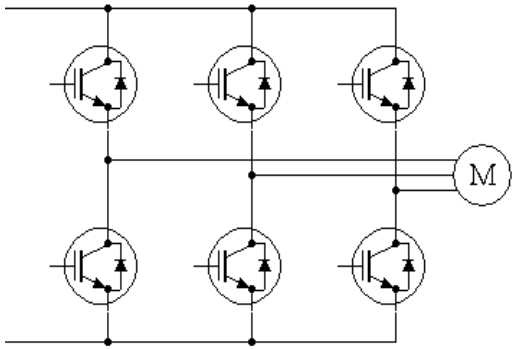
Deep FS by BGSOI
Robust FS layer, Thinner wafer

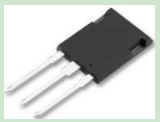


Full Gate
Higher power density, but low Qg by wide pitch



用于驱动控制的分离IGBT产品系列（带短路耐受能力）



Spec					DPAK	D2PAK	TO220	TO220F	TO247-3L	Power247-3L	Application							
Voltage / Current @T_C=100°C	V_{CE_SAT} @T_C=25 °C	IGBT Type	Copak Diode Type	Rated I_F Diode Forward Current @T_C=25 °C							Automotive	EV-Charger	Solar	UPS	IH	Welder	Room AC (PFC)	Motor Control
600 / 15	1.85	RCII T1	FSII	15				NGTB15N60R2FG									V	V
600 / 15	2.2	NPT SC	UltraFast	15			FGP15N60UNDF	FGPF15N60UNDF										V
600 / 10	1.7	RCII T1	FSII	-	NGTB10N60R2DT4G													V
600 / 10	2	NPT SC	UltraFast	10			FGP10N60UNDF	FGPF10N60UNDF										V
600 / 7	1.9	NPT SC	UltraFast	10		FGB7N60UNDF												V
600 / 5	1.65	RCII T1	FSII	5	NGTB05N60R2DT4G													V
600 / 5	1.9	NPT SC	UltraFast	5		FGB5N60UNDF												V
600 / 3	1.7	RCII T1	FSII	3	NGTB03N60R(F)2DT4G													V
600 / 3	2	NPT SC	UltraFast	5	FGD3N60UNDF													V
650 / 100	1.6	FS3 SC	Hyperfast	100						FGY100T65SCDT				V				V
650 / 75	1.7	FSII SC	FSII	75					NGTB75N65FL2			V	V	V				V
650 / 60	1.64	FSII SC	FSII	60					NGTB60N65FL2			V	V	V				V
650 / 50	1.8	FSII SC	FSII	50					NGTB50N65FL2			V	V	V				V
650 / 35	1.7	FSII SC	FSII	35					NGTB35N65FL2				V	V				V

3-phase inverter

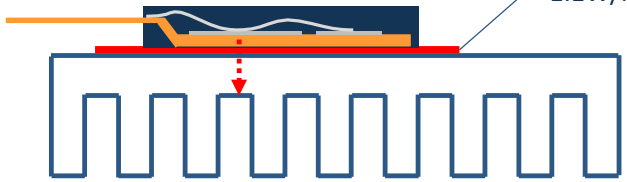
全塑封的TO-3PF封装设计

降低安装成本
提高工作效率

TO3P, TO247

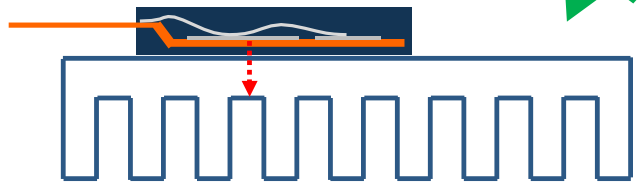
增加成本

绝缘垫片
1.1W/mk,150um (best option)



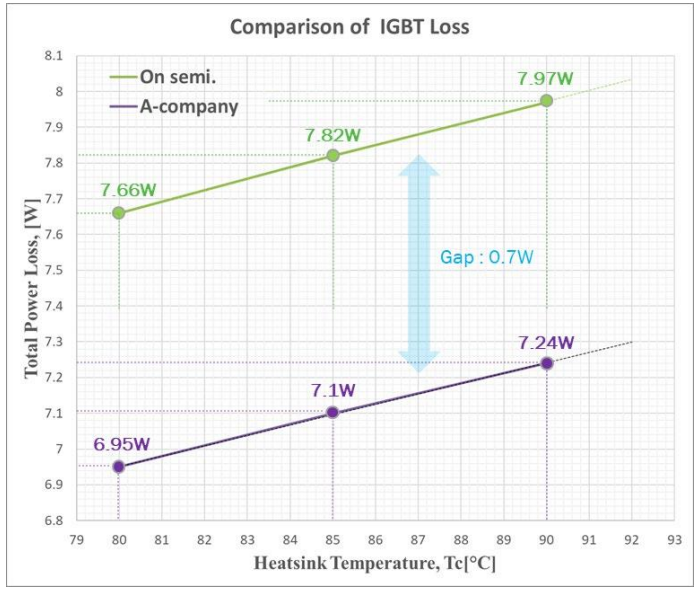
TO3PF

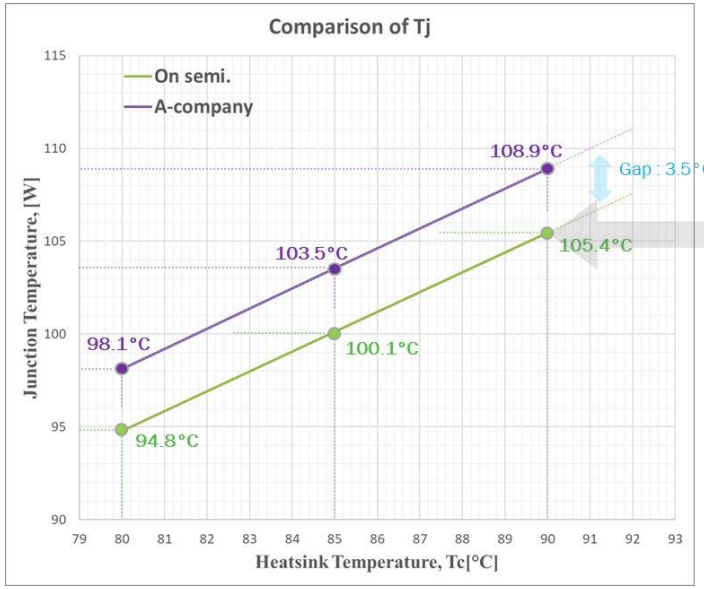
不再需要
绝缘垫片



20% Lower Rthj-h
Compared to
the case of
1.8W/mK, 300um

Simulation conditions	
System topology	Interleaved boost PFC(2-phase)
Operation mode	CCM
Input voltage(Vac)	220[Vac_{rms}, 60Hz]
Input current(Iac)	17[A_{rms}]
Output Voltage(Vdc_link)	380[Vdc_{rms}](△40Vmax, 400V_{max})
Output of Boost Cap.	1.36[mF]
Inductance(L1, L2)	0.22[mH]
Switching Frequency(fsw)	25 [kHz] (each IGBT)
Boost IGBT	FGAF40S65AQ(650V/40A)
Boost Diode(FWD)	VS-60CPU06-F(600/2 x 30A)
Rg_on / Rg_off	27[Ω] / 11.5[Ω]
Power Factor	0.98~0.99(if it is possible)
T_C	80~90 [˚C , T_c = Heatsink temp.]
Load	3-phase Inverter system[SPWM]
Sampling Time	0.5[us]





分离IGBT器件不断迭代发展的动力

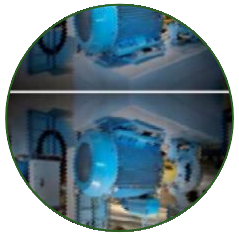
1. 助力客户推出更好的产品
   1. 增加功率密度
      - ✓ 增加功率输出提高功率密度

举例) 同样的Power 247封装，用1200V/100A新一代IGBT替换1200V/75A IGBT可以在损耗相当的情况下，输出更高的功率

- ✓ 减少或减小客户外围的元器件提高功率密度

举例)同样的Power 247封装，用1200V/100A新一代IGBT替换1200V/75A IGBT可以减少损耗缩小散热器尺寸

举例) 提高功率密度减小电感尺寸

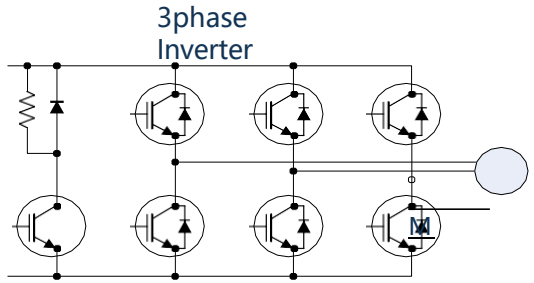


Industrial Motor
600 V/650 V/1200 V SCR
IGBT discrete

1.2 提升可靠性

- ✓ 更窄的Vce和Vth分布便于IGBT并联
- ✓ 减少损耗，降低工作结温利于IGBT长寿命工作
- ✓ 更高的耐压值提高产品可靠性

2. 助力客户减少成本
   - ✓ IGBT自带二极管设计可以减少额外二极管的成本
   - ✓ 提升效率助力减少散热成本
   - ✓ 提高开关效率减少电感以及其他外围器件成本



NPT 600V UQDF

FS3 650V SCD

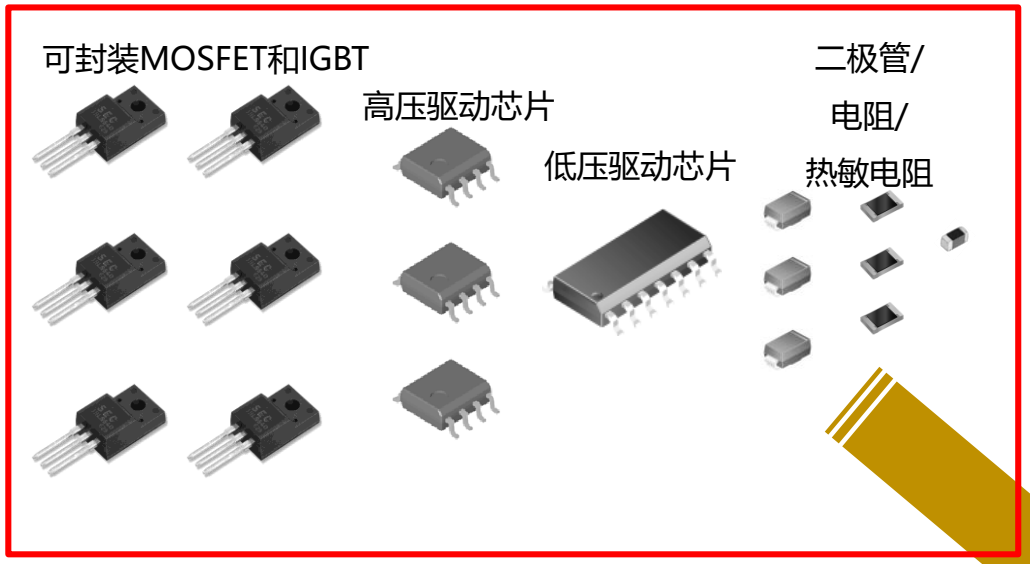
FSII 1200V FL2

RCII 600V SCR

FSII 600V FL2

关于IPM

集成分立功率器件、驱动IC(HVIC)、阻容件和热敏电阻



更灵敏准确的保护功能

- 使用模拟器件的保护电路引起时间延迟和干扰

→ ***IPM 内置HVIC 、LVIC 及保护电路***

更简单的外围元器件设计

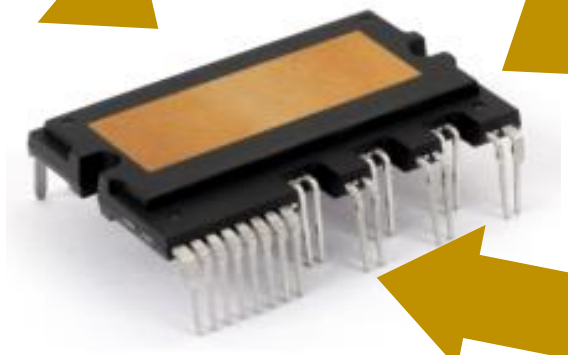
- 需要使用外部器件优化开关和短路耐受特性

→ ***IPM产品优化内置功率器件的驱动特性***

更简化的生产工艺

- 分离方案器件数目多，生产工艺复杂，并导致低产量

→ ***更少的器件数，无需外围器件，使工艺性更好，产量高***

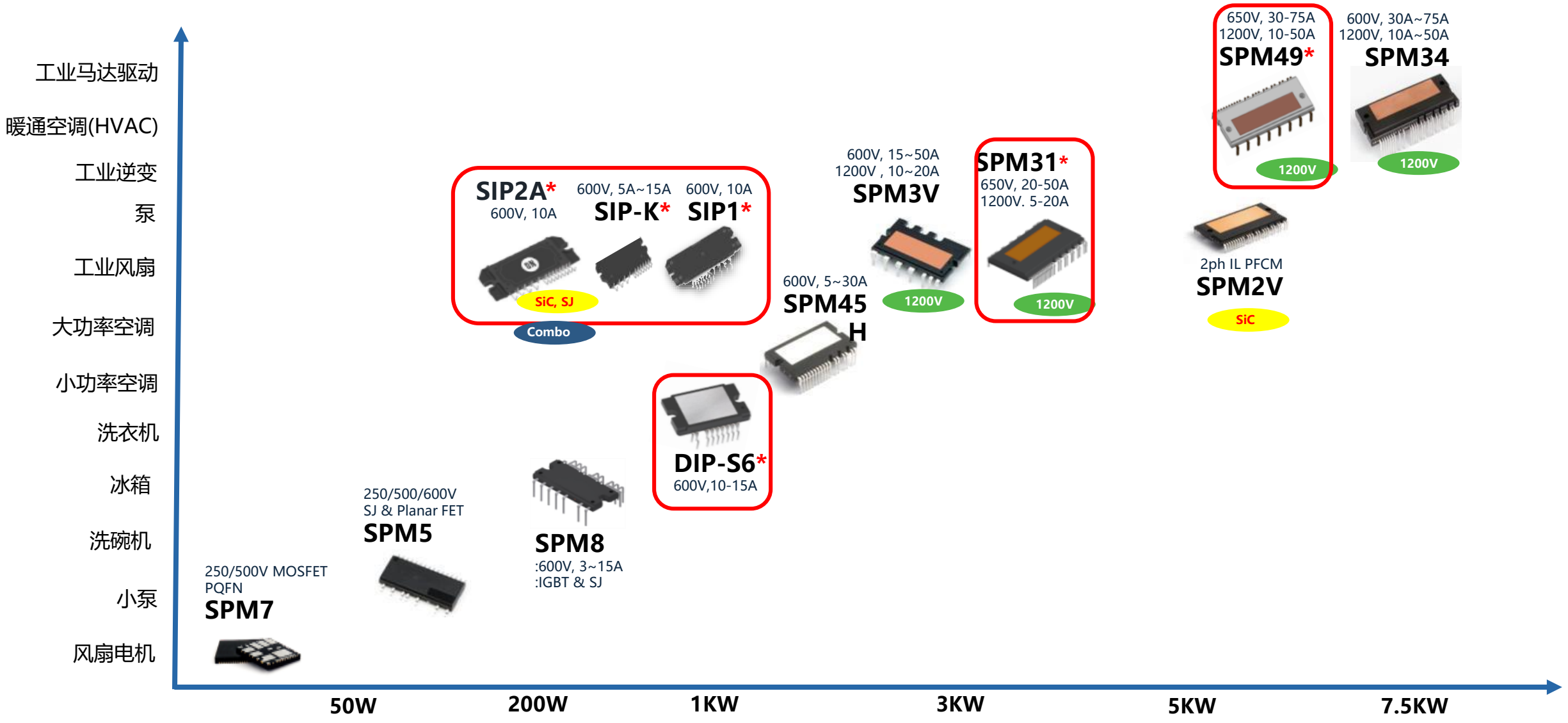


更好的散热性能

- 分立方案需要绝缘垫片，将产生高热阻Rth (j-c)

→ ***出色的热性能，无需绝缘垫片***

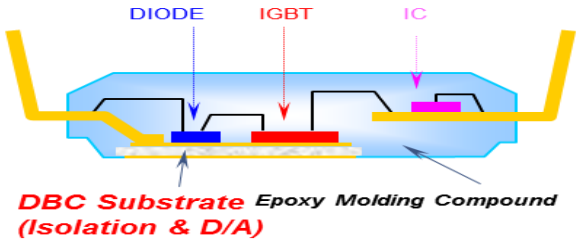
IPM产品阵容



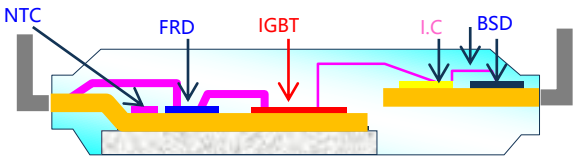
IPM基板技术

直连铜基板(DBC)

直接邦定铜

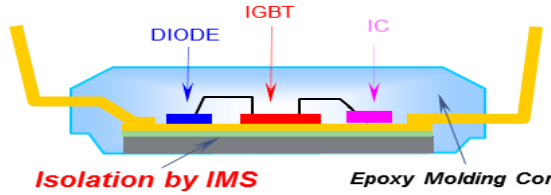


陶瓷基板

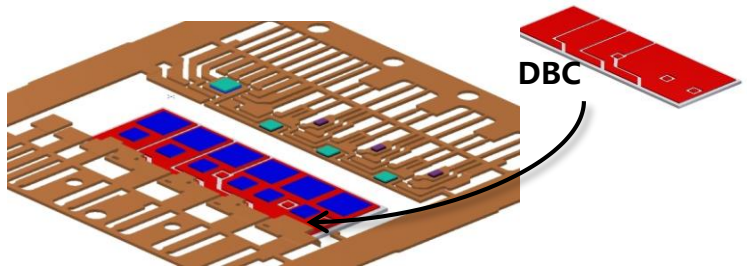


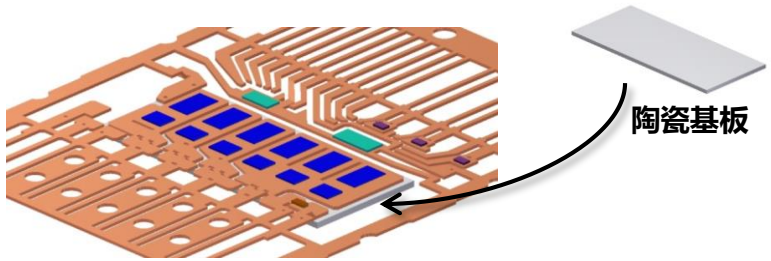
绝缘金属基板(IMST)

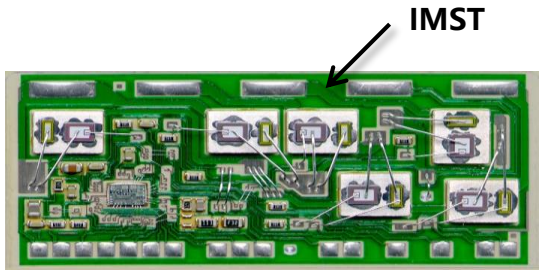
Insulated Metal Substrate Tech.



	直连铜基板(DBC)	陶瓷基板	绝缘金属基板(IMST)
优点	•低热阻 •高隔离电压 (>4kV) •高电流密度及可靠性	•低成本, 易于量产 •高隔离电压(>4kV) •高电流密度	•可高密度贴装 •易贴装各种器件，如电阻器、电容、电感等。
缺点	•成本高 •工序难	• 贴装器件有限	• 电流低
产品	SPM2V, SPM3V, 紧凑的IPM(DIP-S3)	SPM45	SIP 系列, 紧凑的IPM(DIP-S)







工业IPM发展方向

工业IPM阵容扩展

C-HVAC

- **应用**
  - ✓ 压缩机
  - ✓ 户内/户外风扇
  - ✓ 功率因数校正(PFC)
- **目标封装**
  - ✓ SPM3V, SPM31
  - ✓ SPM34, SPM49
  - ✓ ISPM

泵

- **应用**
  - ✓ 水泵
  - ✓ 冷却泵
  - ✓ 真空泵
- **目标封装**
  - ✓ SPM5, SPM7
  - ✓ SPM3V, SPM31
  - ✓ SPM34, SPM49

工业风扇

- **应用**
  - ✓ 鼓风机
  - ✓ 工业风扇
- **目标封装**
  - ✓ SIPK, SIP2A
  - ✓ DIPS6
  - ✓ SPM3V

变频驱动/伺服系统

- **应用**
  - ✓ 机器人
  - ✓ 电绣
  - ✓ 数控(CNC)
- **目标封装**
  - ✓ SPM3V, SPM31
  - ✓ SPM34, SPM49
  - ✓ ISPM

IPM方案用于工业

已推出 | 新产品

ON Semiconductor®

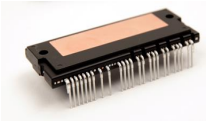
1200V 系列

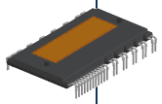
SPM34 1200V / 10A, 25A, 30A, 50A

新产品 SPM49 1200V / 10A, 25A, 35A, 50A

SPM3V 1200V / 10A, 15A, 20A

新产品 SPM31 1200V / 5A, 10A, 20A





ON Semiconductor®

600/650V 系列

SPM34 600V / 30A, 50A, 75A

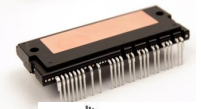
新产品SPM49 650V / 30A, 50A, 75A

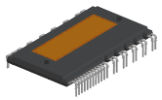
SPM3V 600V / 15A, 20A, 30A, 40A, 50A

新产品 SPM31 650V / 20A, 30A, 50A

SPM45 600V / 5A, 8A, 10A, 15A, 20A, 30A

新产品 DIP-S6 600V / 5A,10A, 15A,

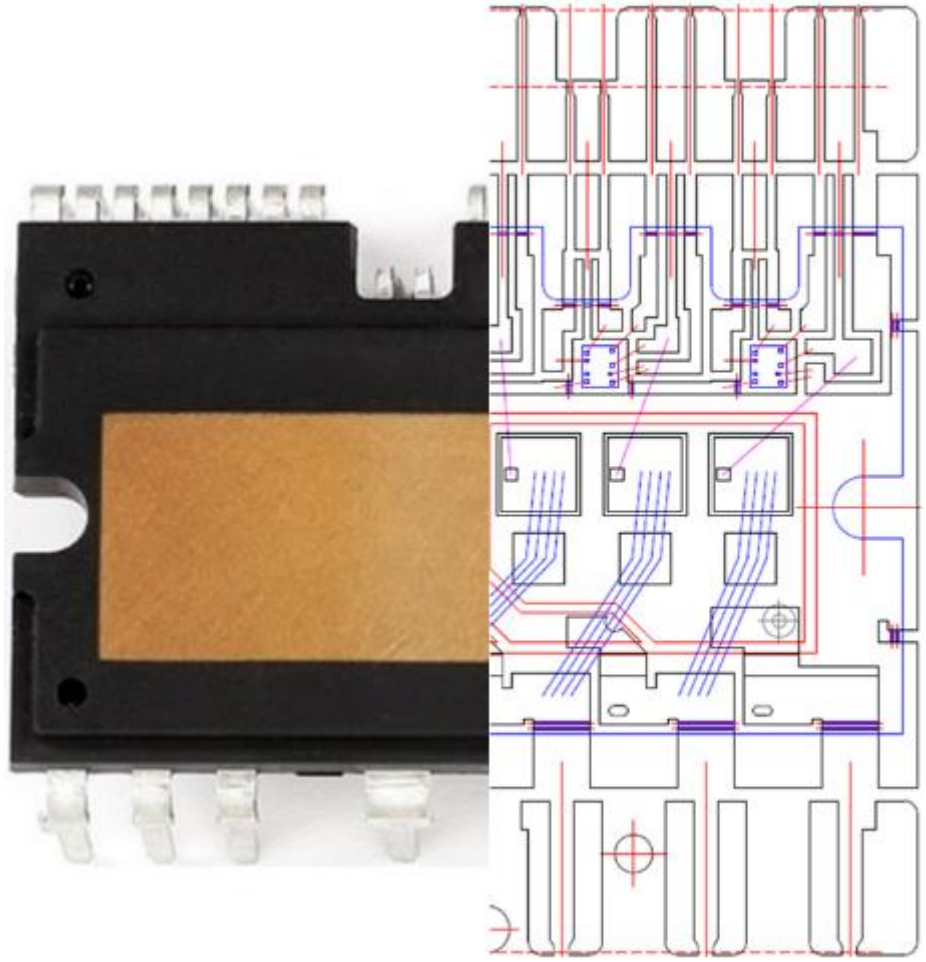




10A 20A 30A 50A 75A

IPM不断迭代发展的动力

- 为马达驱动控制提供智能功率模块，提高功率密度
- 为工业客户提供更灵敏准确的保护功能，更简单的外围元器件设计、更快速的生产工艺和更好的散热性能。
- 安森美为客户提供1200V和650V/600V全系列的IPM产品，最高功率等级7.5kW。
- DBC技术可提供更好的热性能特性
- 新一代的IGBT产品可提供更好的开关特性，助力提升能效



SPM®49

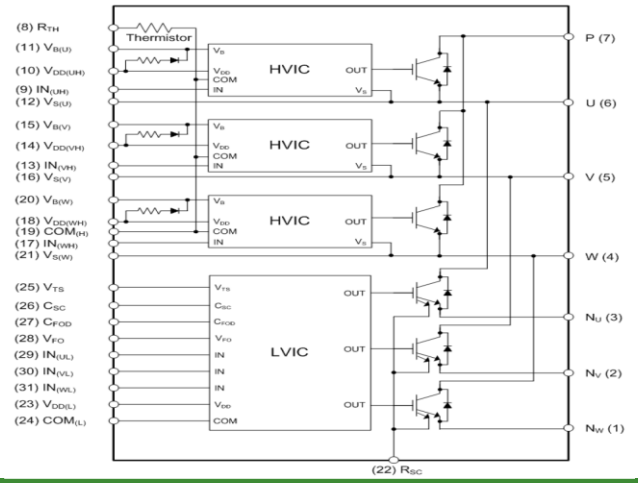
特性

- 引脚兼容 ‘M’ 公司 Large DIP产品
- 先进的1200V & 650V 沟槽型的短路耐受 IGBT
- 使用直连铜基本技术，极低的热阻，(Al2O3，AlN)
- 集成自举二极管和热敏电阻
- 更远的爬电距离

优势

- 完全兼容”M”公司Large DIP产品
- 全功率等级覆盖；30A~75A/600V，10~50A/1200V
- 极低的热阻带来极佳的散热性

框图



规格

1200V Line up

Product	Voltage	Current	$V_{CE(SAT)}$ typ.	Substrate	Status
NFAL3512L5B(T)	1200V	35A	(1.9)	DBC(Al2O3)	MP
NFAL5012L5B(T)	1200V	50A	(1.9)	DBC(Al2O3)	MP

650V Line up

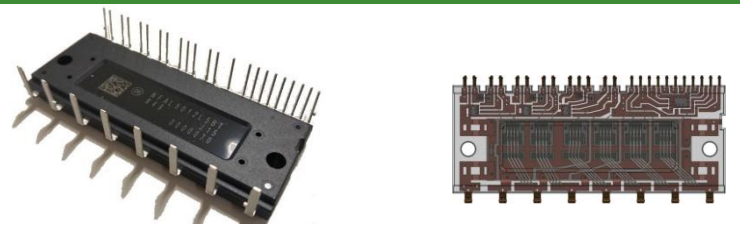
Product	Voltage	Current	$V_{CE(SAT)}$ typ.	Substrate	Status
NFAL5065L4B(T)	650V	50A	1.55	DBC(Al2O3)	MP
NFAL7565L4B(T)	650V	75A	1.55	DBC(Al2O3)	MP

T: NTC option

目标应用

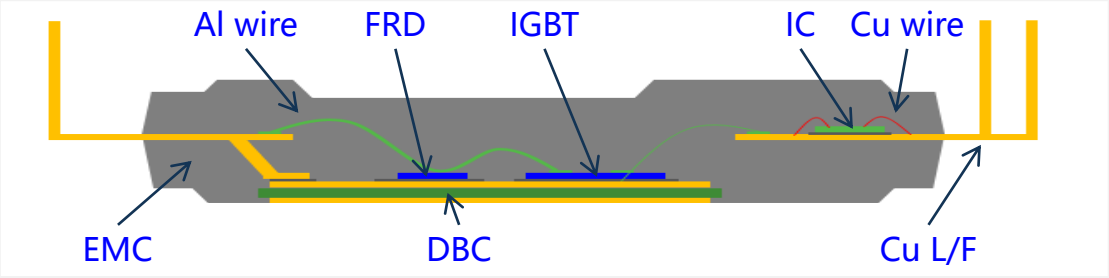
- 大功率空调
- 工业逆变器
- 工业泵
- 工业风扇

封装; 79 mm × 31 mm × 8 mm

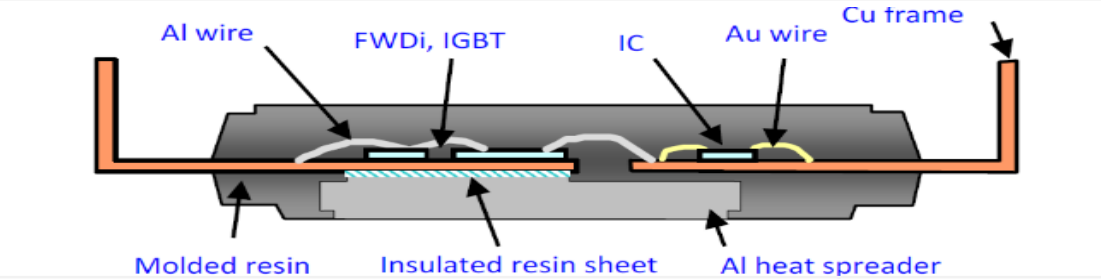


更优的性能

- 相同封装尺寸下更好的隔离距离
- 采用DBC基板具有更高的热性能和可靠性
- 抗短路破坏的强固封装结构



< 安森美半导体的大的DIP P2P 产品>



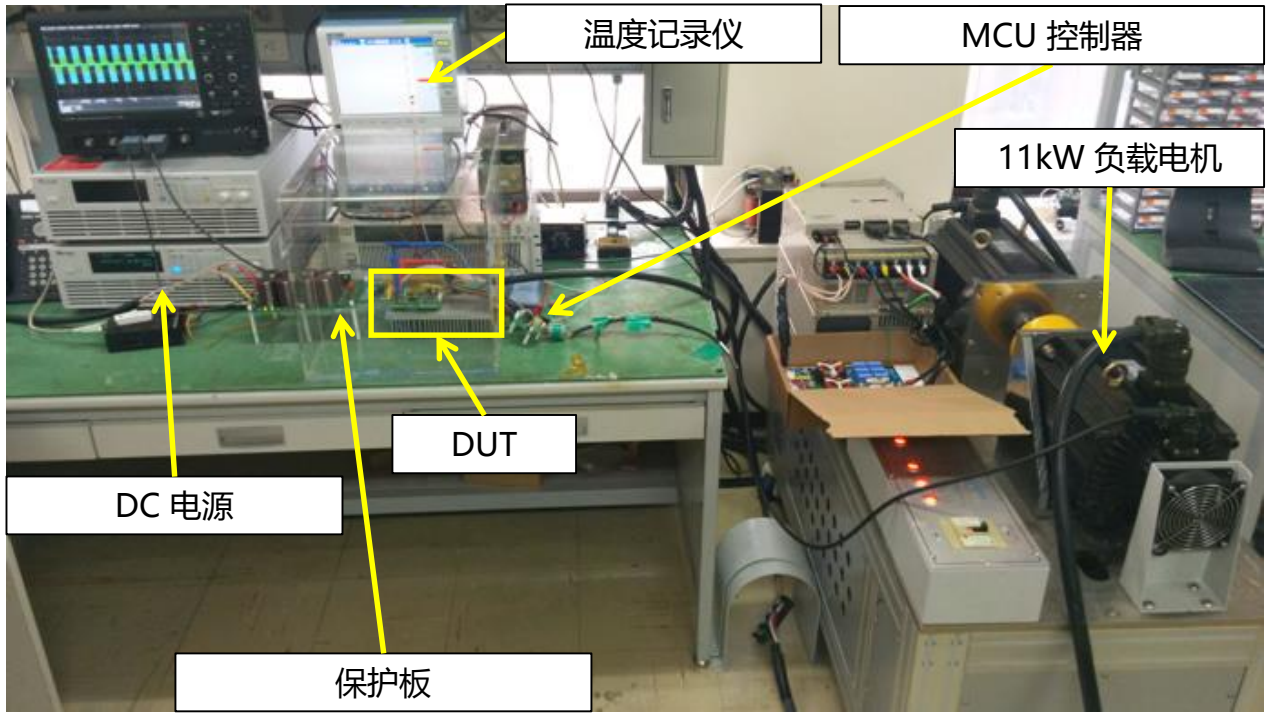
< 竞争对手的大的DIPPM™>

项目		SPM49	竞争对手	优缺点
隔离距离(mm)	爬电距离	5.7 / 7.3	5.6 / 7.3	更大的爬电距离
	电气间隙	4.0	3.8	更大的电气间隙
基板	材料	DBC (Al2O3, or ALN)	Al heat spreader + Adhesive	更好的热性能 ※ 大的DIP Rthjc : 通过Al2O3仿真数据
	厚度	1.3mm (0.4mm/0.5mm/0.4mm)	3.3mm	
	尺寸(mm)	59.3 × 17.90	68.5 x 16.4	
	热阻Rthjc (°C/W)	IGBT: max 0.67, FRD: max 0.97	IGBT: max 0.81, FRD: max 1.25	

热性能

条件: V_{DC} = 300V, V_{DD} = 15V, F_{SW} = 5kHz(I_O = 27 / 47A_{RMS}) 及外部风扇(8V), 15kHz(I_O = 22 / 29.5A_{RMS}) 及外部风扇(13V), 电机速度: 1200RPM

DUT : 竞争对手, NFAL7565L4BT WS



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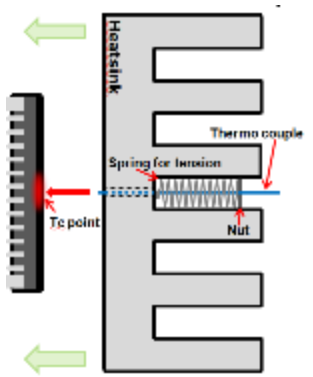
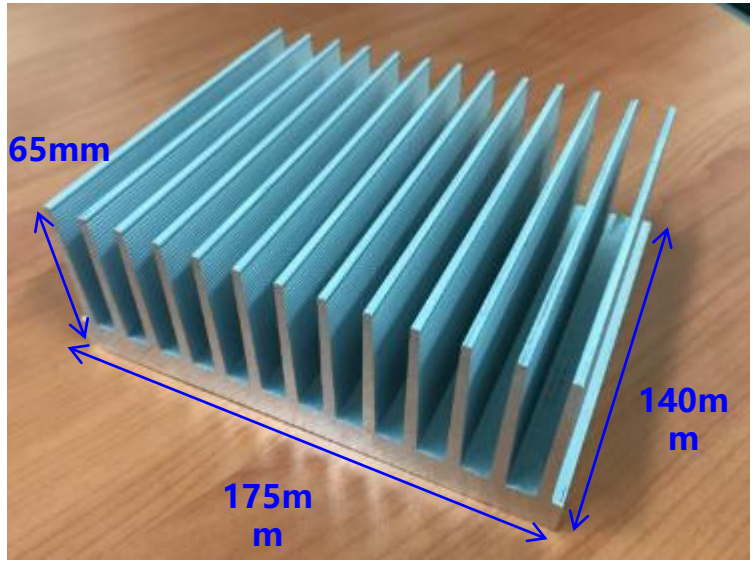
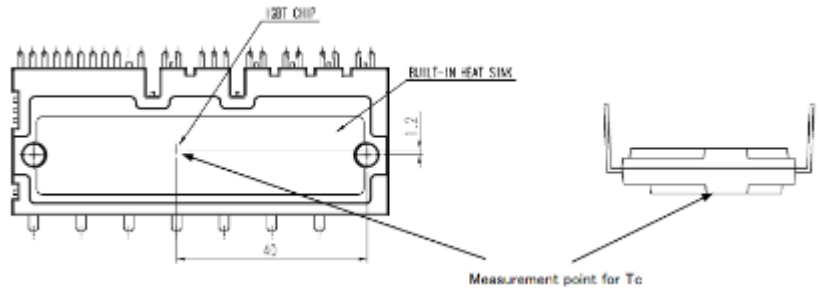




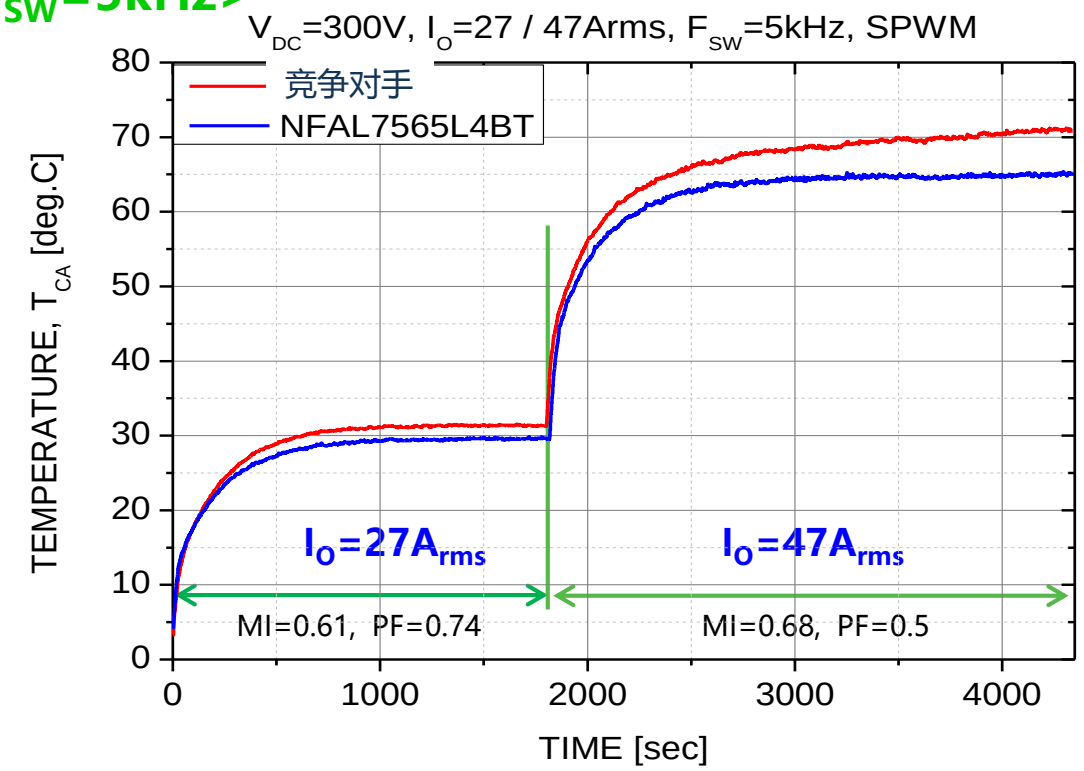
<散热器>



<管壳温度. 测量点>

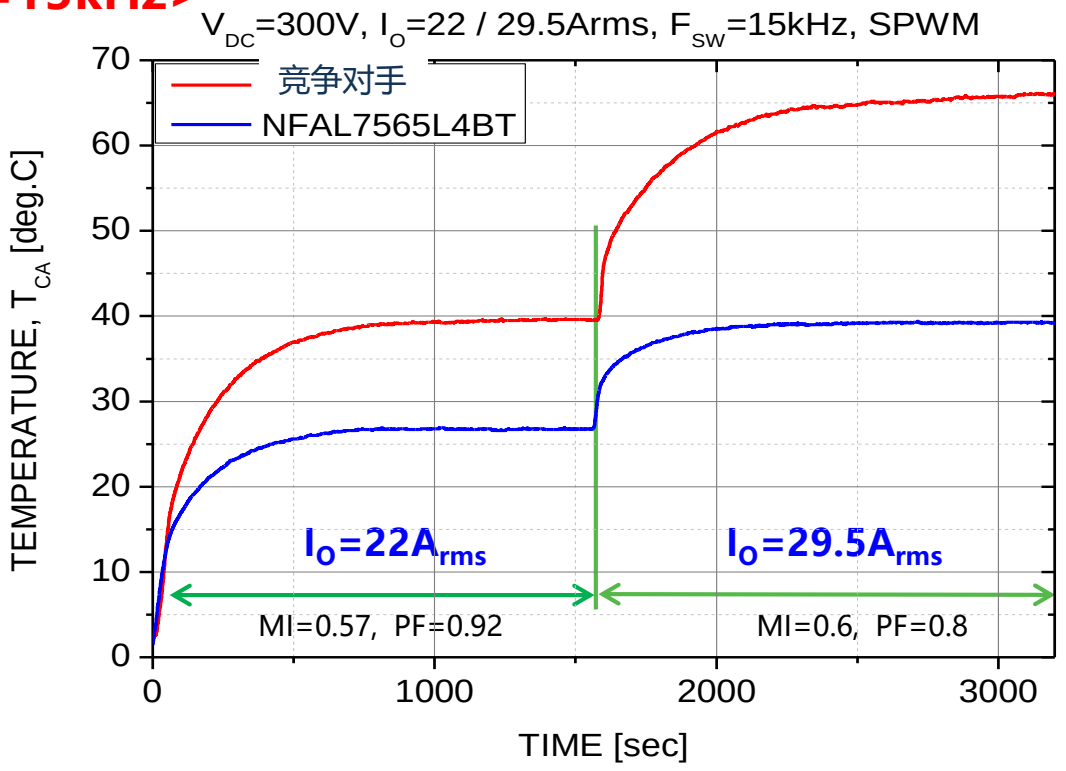
热性能

<F_{SW}=5kHz>



产品/ 温度	T_A / T_C / T_{CA} [°C]@ 27A_{rms}			T_A / T_C / T_{CA} [°C]@ 47A_{rms}		
竞争对手	27.6	58.8	31.2	31.7	102.7	71
NFAL7565L4BT	27.5	57.1	29.6	31.9	97.3	65.4

<F_{SW}=15kHz>



产品/ 温度	T_A / T_C / T_{CA} [°C]@ 22A_{rms}			T_A / T_C / T_{CA} [°C]@ 29.5A_{rms}		
竞争对手	27.3	66.9	39.6	29.5	95.7	66.2
NFAL7565L4BT	28	54.7	26.7	29.6	68.8	39.2

在所有F_{SW} / I_O 测试条件下，NFAL7565L4BT的T_{CA} 比竞争对手低

SPM®31

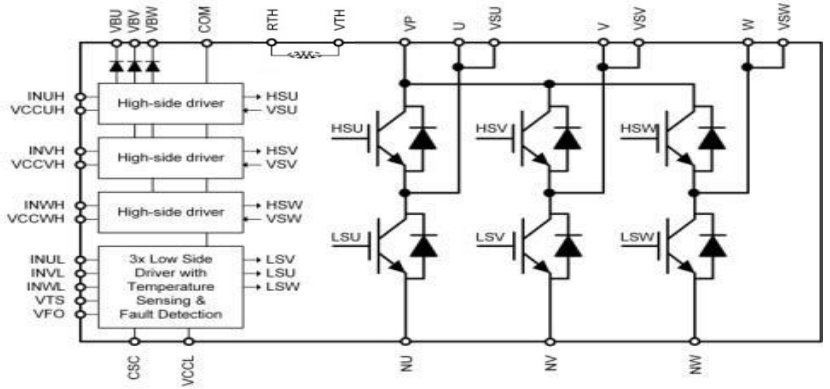
特性

- 引脚兼容 ‘M’ 公司 Mini DIP产品
- 先进的650V 沟槽型的短路耐受 IGBT
- 使用直连铜基本技术，极低的热阻，(Al2O3，AlN)
- 集成自举二极管和热敏电阻
- 更远的爬电距离

优势

- 完全兼容”M”公司Large DIP产品
- 全功率等级覆盖；30A~50A/650V，
- 极低的热阻带来极佳的散热性

框图



规格

1200V Line up

Product	Voltage	Current	$V_{CE(SAT)}$ typ.	Substrate	Status
NFAM1012L5B(T)	1200V	10A	(1.8)	DBC(Al2O3)	MP
NFAM2012L5B(T)	1200V	20A	(1.8)	DBC(Al2O3)	MP

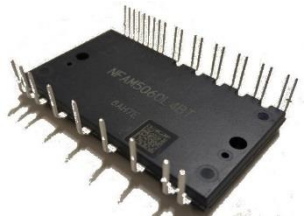
650V Line up

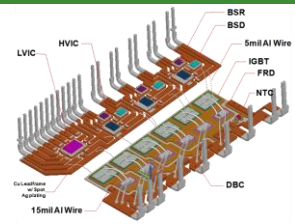
Product	Voltage	Current	$V_{CE(SAT)}$ typ.	Substrate	Status
NFAM2065L4B(T)	650V	20A	(1.7)	DBC(Al2O3)	MP
NFAM3065L4B(T)	650V	30A	(1.7)	DBC(Al2O3)	MP
NFAM5065L4B(T)	650V	50A	(1.7)	DBC(Al2O3)	MP

目标应用

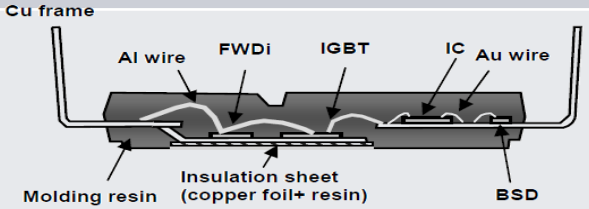
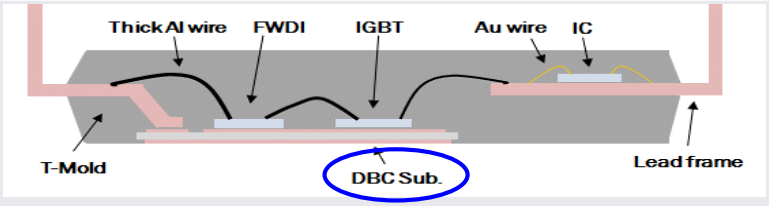
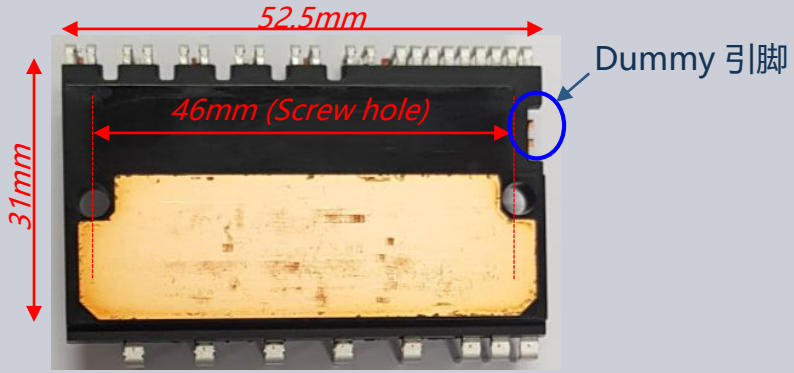
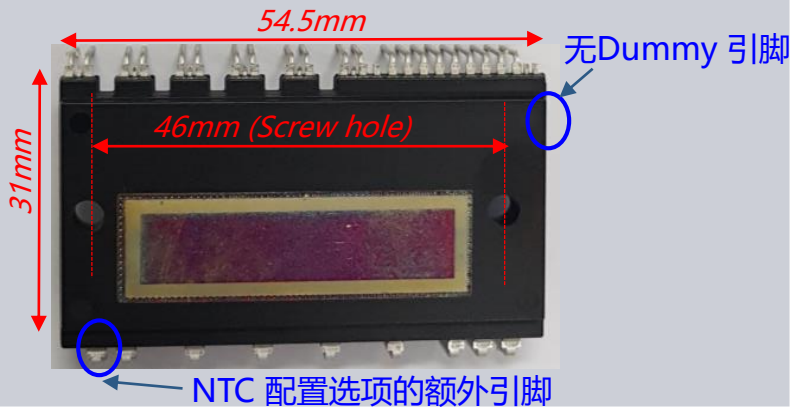
- 大功率空调
- 工业逆变器
- 工业泵
- 工业风扇

封装; 54.5 mm × 31 mm × 5.6 mm





封装比较

	竞争对手	安森美半导体SPM31
封装尺寸[mm]	52.5 x 31.0 x 5.6	54.5 x 31.0 x 5.6 螺丝孔和引脚兼容(插入式)
基板	引线框架+ 绝缘片	DBC
热阻(600V/30A)	1.17℃/W	1.03℃/W (降12%)
横截面 *图像		
布板 蓝圈: hanging pin位置 绿圈 : 额外的NTC		

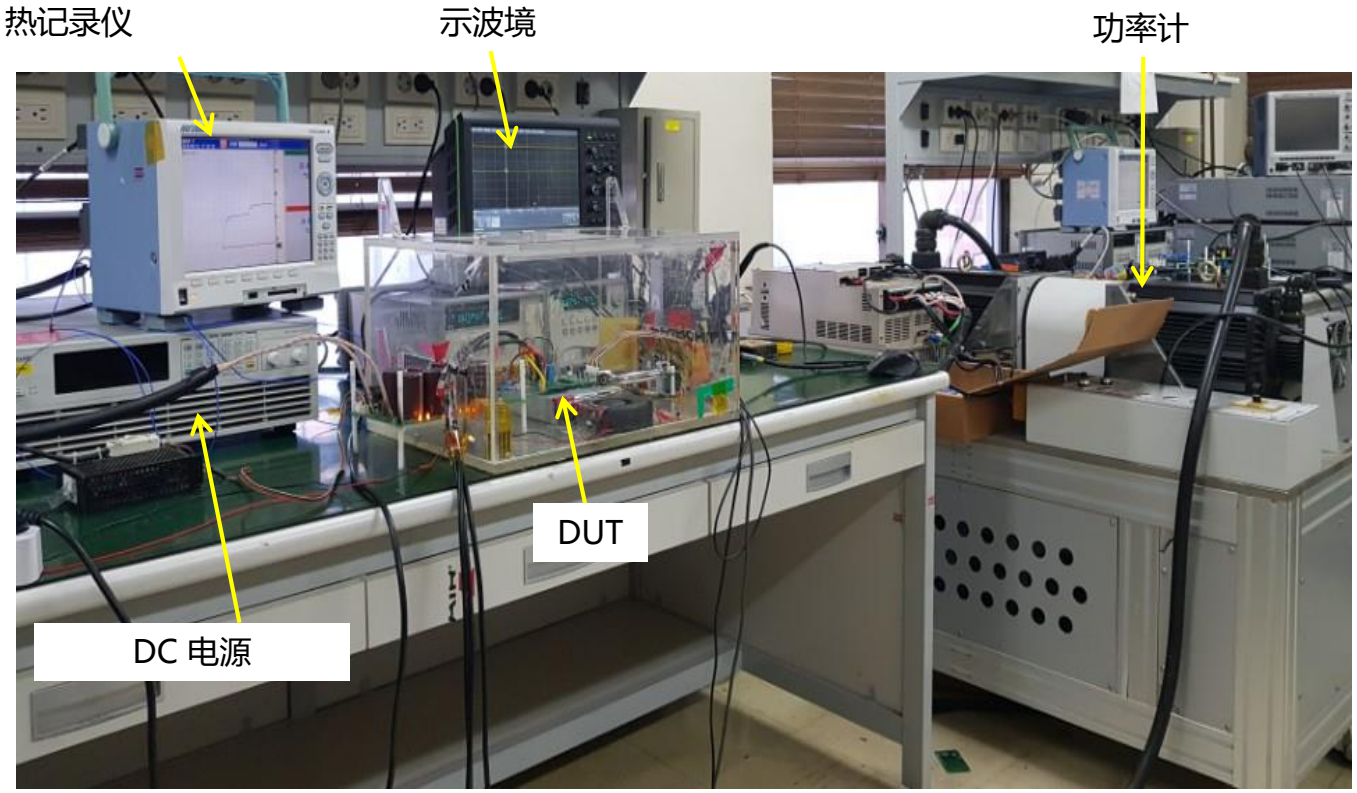
✓**DBC 基板**
✓**引线引脚和螺丝孔兼容设计**
✓**侧面无虚设引脚**
✓**NTC 热检测配置选项(DBC)**

➔**出色的导热性和高可靠性**
➔**无需PCB再设计**
➔**散热器设计灵活性改进**
➔**更精确和直接的检测**

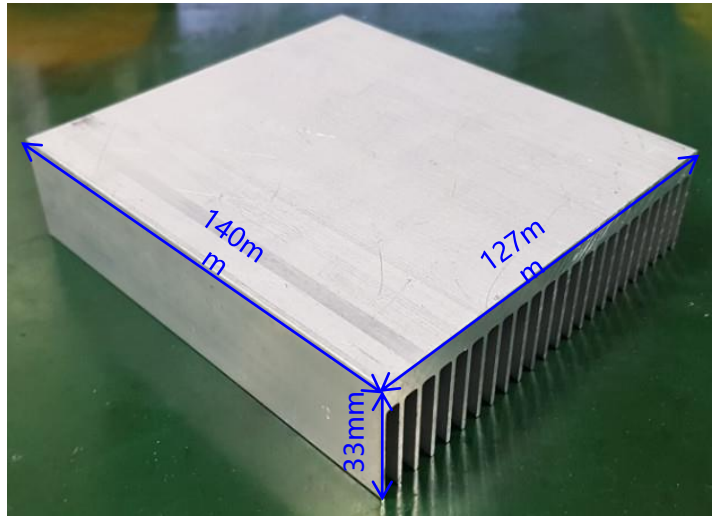
热性能

✓条件: V_{DC}=300V, V_{CC}=15V, F_{SW}=5kHz(I_{OUT}=15 / 30A_{RMS}), 15kHz(I_{OUT}=15 / 18A_{RMS}), Fan 11.0V

✓DUT : NFAM5060L4B1及竞争对手

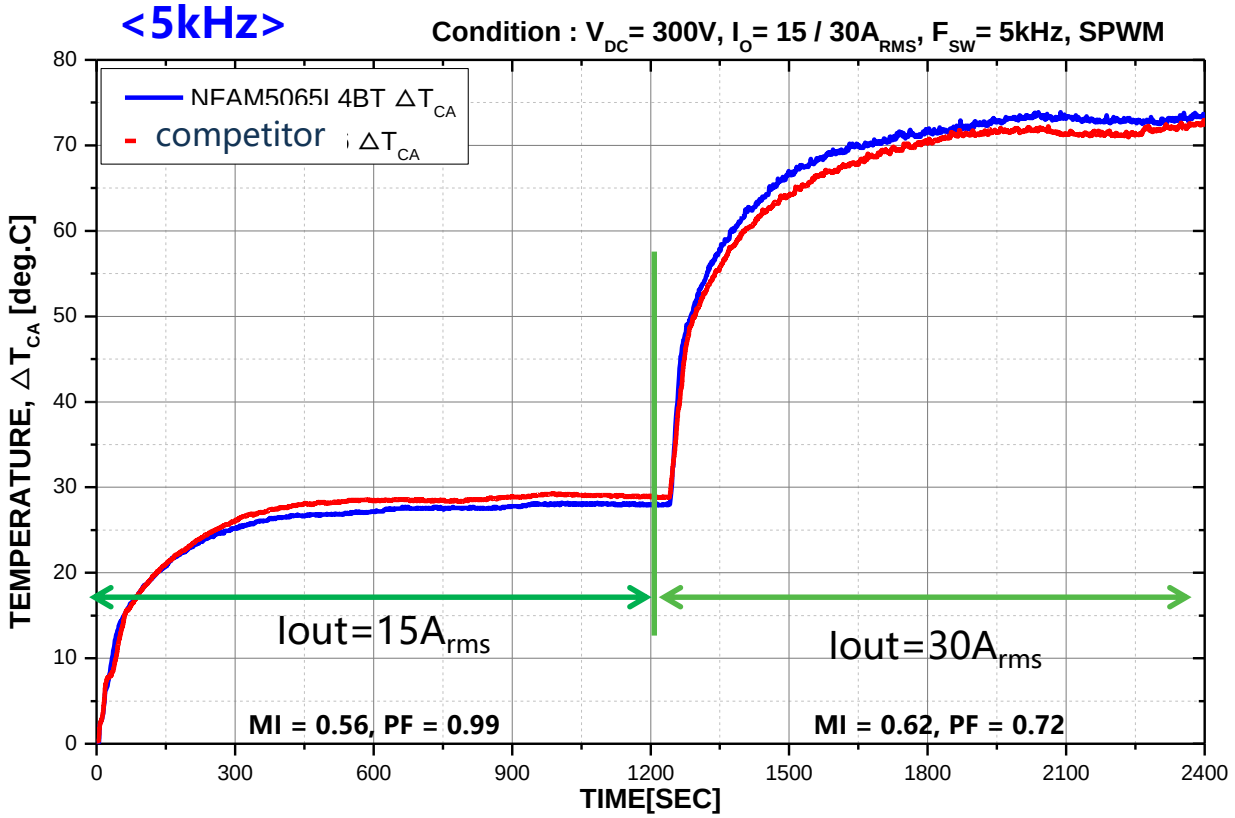


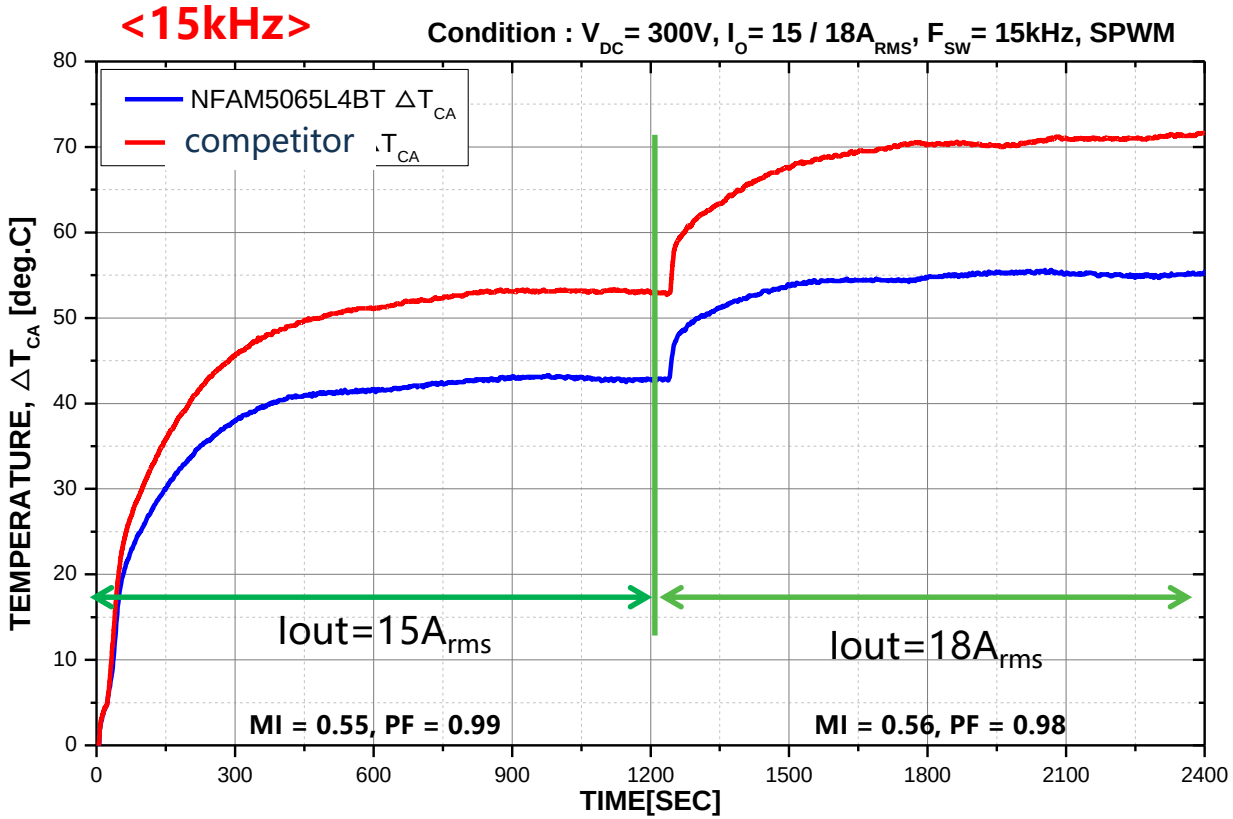
[测试装置]



[散热器]

热性能

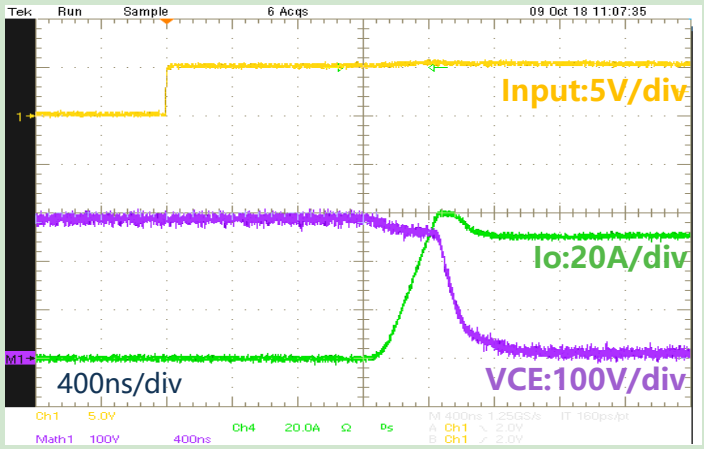
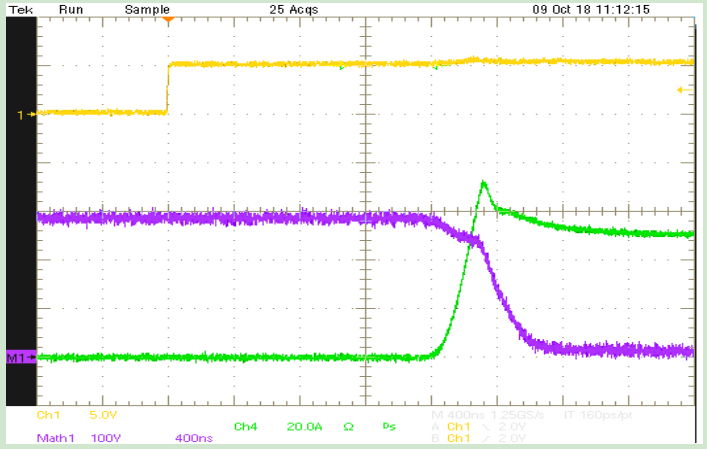
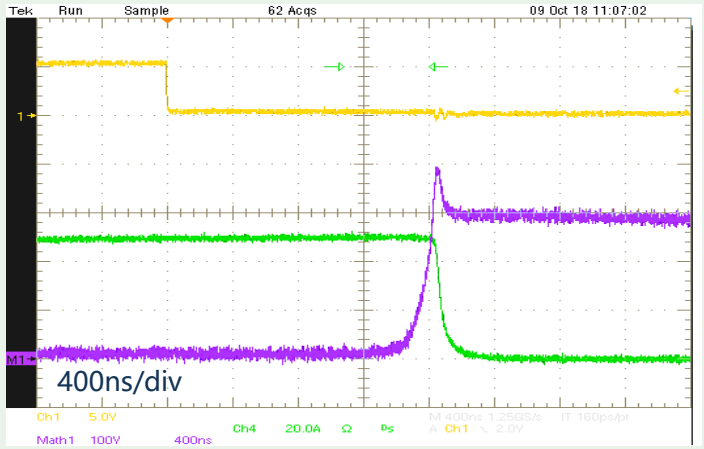
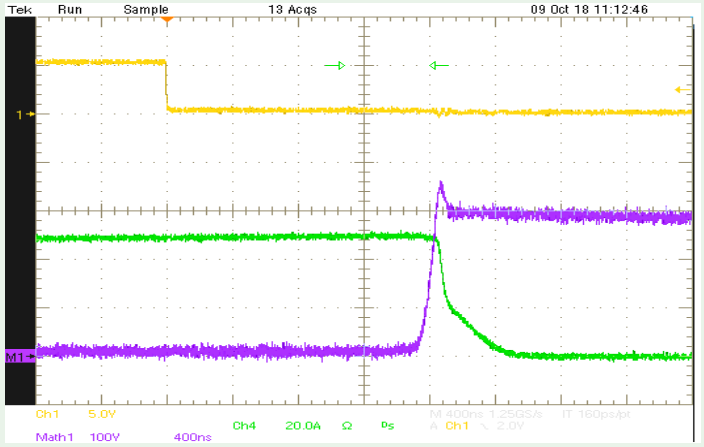




产品/ 温度	T_A[°C] (15A_{rms})	T_{CA}[°C] (15A_{rms})	T_A[°C] (30A_{rms})	T_{CA}[°C] (30A_{rms})
NFAM5065L4BT	23.6	28.0	25.7	73.2
竞争对手	23.6	29.0	25.5	72.5

产品/ 温度	T_A[°C] (15A_{rms})	T_{CA}[°C] (15A_{rms})	T_A[°C] (18A_{rms})	T_{CA}[°C] (18A_{rms})
NFAM5065L4BT	24.2	42.8	25.3	55.4
竞争对手	24.8	52.9	25.8	71.6

SPM31：开关波形@ Tj=150degC

	NFAM5065L4BT	竞争对手
开		
关		

SPM®34(达7.5kW)

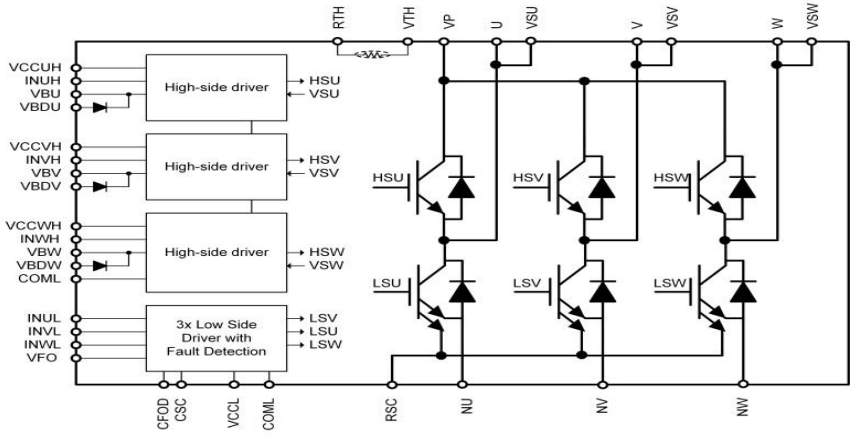
特性

- 先进的650V 和1200V 沟槽型的短路耐受 IGBT
- 使用直连铜基本技术，极低的热阻， (Al2O3，AlN)
- 集成自举二极管和热敏电阻
- 更远的爬电距离

优势

- 系列产品间完全兼容
- 全功率等级覆盖；30A~100A/600V，
- 极低的热阻带来极佳的散热性

框图



规格

1200 V Line up

Product	Voltage	Current	$V_{CE(SAT)}$ typ.	Substrate	Status
FNA21012A	1200V	10A	2.20V	DBC(Al2O3)	MP
FNA22512A	1200V	25A	1.90V	DBC(Al2O3)	MP
FNA23512A	1200V	35A	1.90V	DBC(Al2O3)	MP
FNA25012A	1200V	50A	TBD	DBC(AlN)	MP

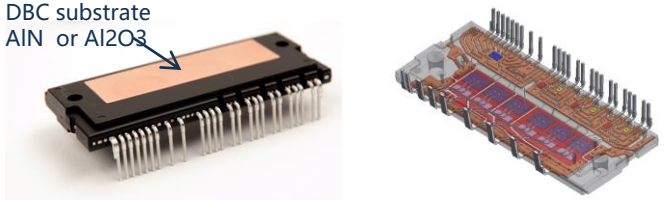
600 V Line up

Product	Voltage	Current	$V_{CE(SAT)}$ typ.	Substrate	Status
FNA23060	600V	30A	1.50V	DBC(Al2O3)	MP
FNA25060	600V	50A	1.50V	DBC(Al2O3)	MP
FNA27560	600V	75A	1.30V	DBC(Al2O3)	MP

目标应用

- High power Air conditioner
- Industrial Inverters
- Industrial Pumps
- Industrial Fans

封装; 80 mm × 33 mm × 8 mm



SPM®3 V(达5kW)

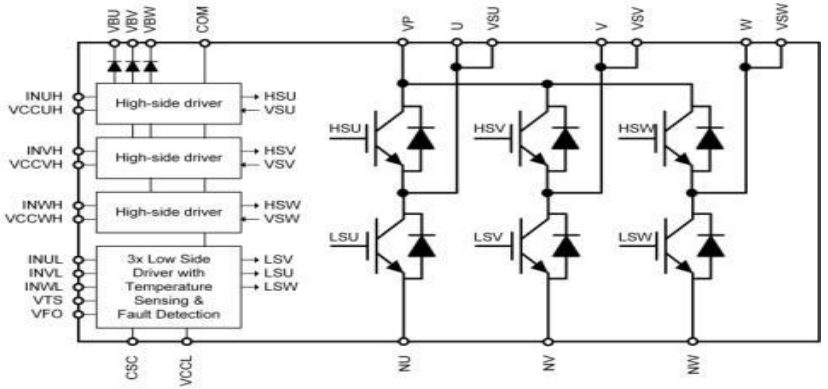
特性

- 先进的650V 和1200V 沟槽型的短路耐受 IGBT
- 使用直连铜基本技术，极低的热阻， (Al2O3 , AlN)
- 通过热侦测实现全面的保护功能

优势

- 系列产品间完全兼容
- 全功率等级覆盖；10A~20A/1200V , 15A~50A/600V
- 极低的热阻带来极佳的散热性

框图



规格

1200 V Line up

Product	Voltage	Current	$V_{CE(SAT)\ Typ}$	Substrate	Status
FSBB10CH120D(F)*	1200V	10A	2.20V	DBC(Al2O3)	MP
FSBB15CH120D(F)*	1200V	15A	(1.60)V	DBC(Al2O3)	MP
FSBB20CH120D(F)*	1200V	20A	(1.85)V	DBC (AlN)	MP

*Thermal sensing Unit : Suffix 'F' : -25~125°C , no 'F' : 0~150°C

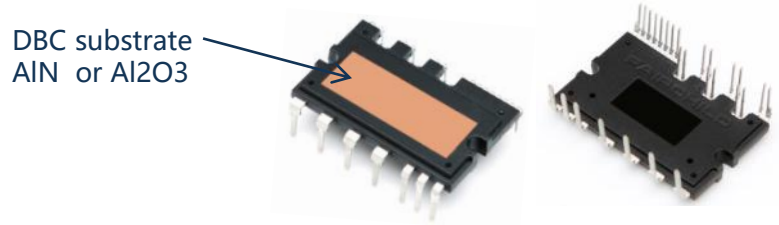
600 V Line up

Product	Voltage	Current	$V_{CE(SAT)\ Typ}$	Substrate	Status
FSBB15CH60D	600V	15A	2.00V	DBC(Al2O3)	MP
FSBB20CH60D	600V	20A	2.00V	DBC(Al2O3)	MP
FNB33060T	600V	30A	1.60V	DBC(Al2O3)	MP
FNB34060T	600V	40A	1.50V	DBC(Al2O3)	MP
FNB35060T	600V	50A	1.65V	DBC (AlN)	MP

目标应用

- High power Air conditioner (3HP~7HP)
- Industrial Inverters
- Industrial Pumps
- Industrial Fans

封装: 44 mm × 26.8 mm× 5.5 mm



SPM® 45 (500W 至 2.2kW)

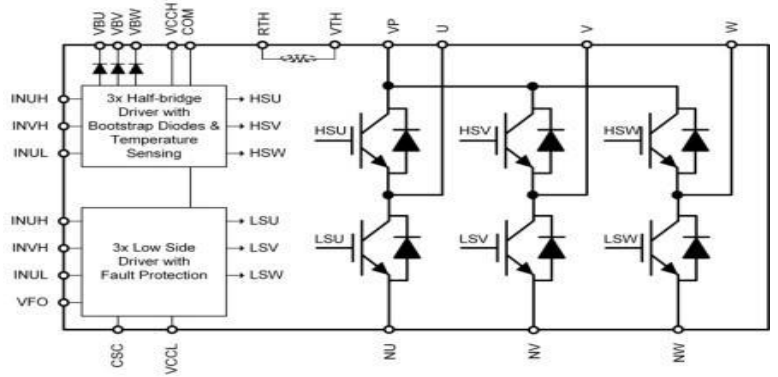
特性

- 兼顾散热和成本的高性价比方案
- 电流覆盖 从5A 到30A
- 内置自举二极管
- 内置热敏电阻
- 引脚复用功能兼容更多需求

优势

- 统一封装兼容1P到3P空调
- 电磁兼容性能更好， 温度特性更好
- 工作异常后，完善的保护性能

框图



规格

Product	Voltage	Current	$V_{CE(SAT)}$	Substrate	Status
FNA40560	600V	5A	1.90V	Ceramic	MP
FNA40860	600V	8A	1.70V	Ceramic	MP
FNA41060	600V	10A	1.70V	Ceramic	MP
FNA41560T2	600V	15A	1.60V	Ceramic	MP
FNC42060F2	600V	20A	1.85V	Ceramic	MP
FND42060F2	600V	20A	1.85V	Ceramic	MP (No dummy pin)
FNB43060T2	600V	30A	1.65V	Ceramic	MP
FND43060T2	600V	30A	1.65V	Ceramic	MP (No dummy pin)

SPM45 V4 RC

Product	Voltage	Current	$V_{CE(SAT)}$	Substrate	Status
NFA41560R42	600V	15A	TBD	Ceramic	ES: Now MP: Q1 21
NFA42060R42	600V	20A	TBD	Ceramic	ES: Now MP: Q1 21

目标应用

- Air conditioner
- Pumps
- Compact industrial Inverters
- Refrigerator, Washing Machine

Package & No side dummy ；39mm × 23mm

Side dummy for stable assembly

Remove side dummy for wider creepage after r

DIP-S6/ DIP-S (200W至1.1kW)

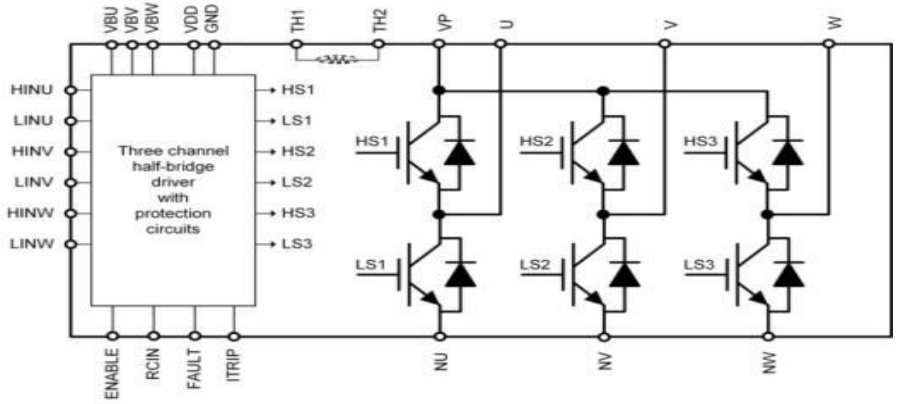
特性

- 极低的热阻实现高功率密度
- 优化的IGBT和二极管在兼顾电磁兼容性能的同时，可实现低损耗
- 过流保护和欠压保护
- 直通保护
- 实时探测壳温

优势

- 更小和更好的散热性能降低系统成本
- 异常状况下完善的保护性能

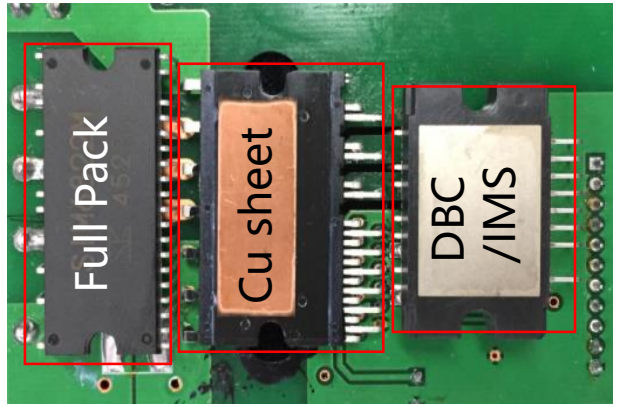
框图



规格

Product	Voltage	Current	$V_{CE(SAT)}$	Substrate	Status
STK5C4U332J-E	600V	3A	1.6V	IMST+FP	MP
NFAQ0560R46T	600V	5A	TBD	DBC	ES: Ready, MP: Dec'20
NFAQ0860L36T	600V	8A	2.4V	DBC	MP
NFAQ1060L36T	600V	10A	1.9V	DBC	MP
NFAQ1560R46T	600V	15A	TBD	DBC	ES: Ready, MP: Dec'20

优势: 紧凑，热阻Rth 低

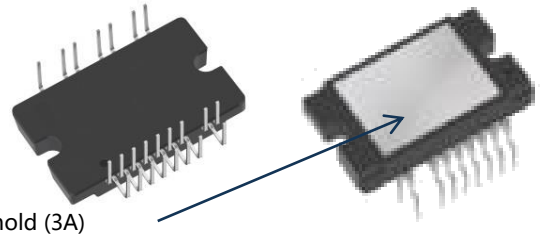


竞争对手　竞争对手　ON　'DIPS(3)'

目标应用

- 洗衣机
- 空调
- 风扇
- 冰箱 / 洗衣干衣机 / 泵类产品

封装；29.6mm× 18.2mm× 3.4

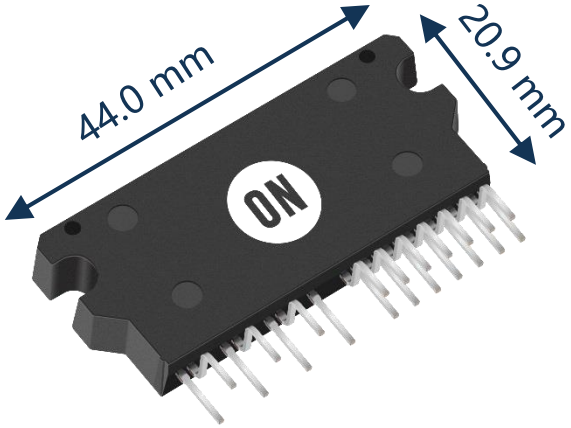


-IMST + Full mold (3A)
-Thin DBC substrate (10~15A)

SIP方案用于工业

SIP-K 新方案

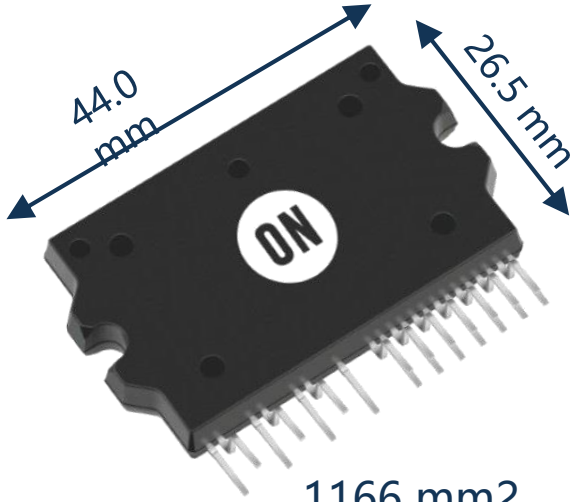
基板: IMST+Fullpack
额定值: 600V 5A/10A/15A
目标应用: 工业逆变, 泵



836 mm2

SIP05

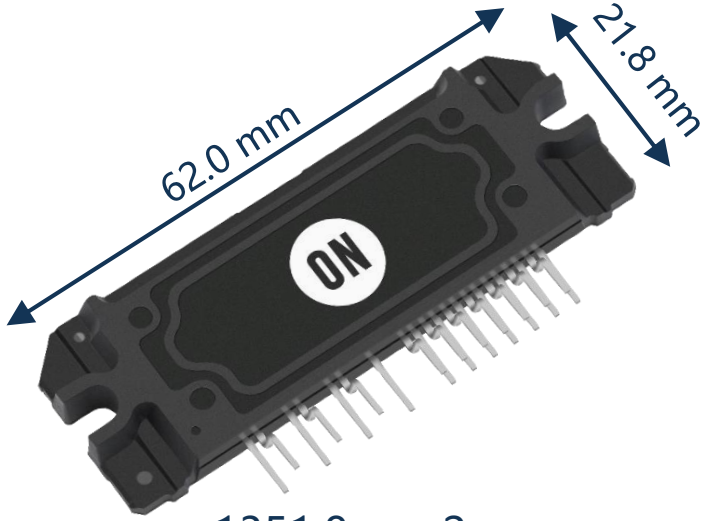
基板: IMST+Fullpack
额定值: 600V 5A/10A/15A
目标应用: 工业逆变, 泵



1166 mm2

SIP1A, SIP1

基板: IMST+Fullpack
额定值: 600V 10A(SIP1), 600V 10A/15A(SIP1A)
目标应用: 工业逆变, 泵



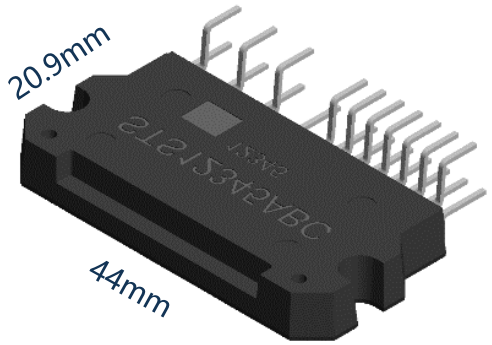
1351.8 mm2

- ✓ **SIP-K 是新平台，可取代现有的SIP (600V 5A/10A/15A)**
- ✓ **比现有SIP 方案更小的封装尺寸(▵38% vs SIP1A, ▵21% vs SIP05)**
- ✓ **与SIP1A/SIP05 相同的输出引脚，易于取代**

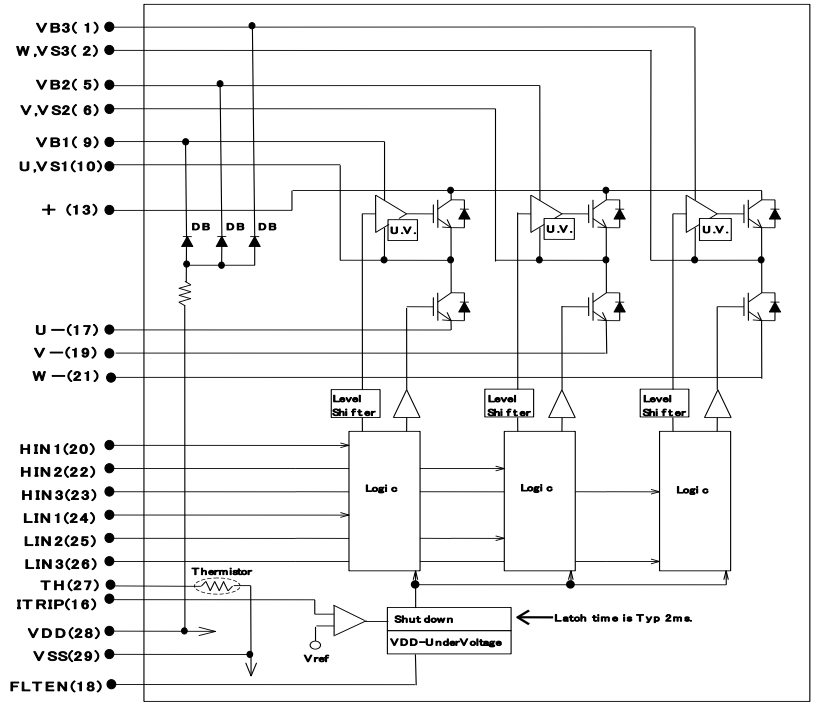
SIP-K(新的SIP)

概念

- 引脚兼容 SIP1A & SIP05F
- 和 SIP05F一样的安装孔位置
- 封装尺寸更小
- 新的IGBT & FRD 工艺
  - FS3 trench IGBT
  - Extreme Fast Diode



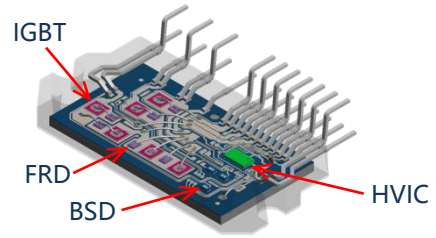
框图



系列

Product	Voltage	Current	Substrate	Input Logic	Status
NFAP0560L3TT	600V	5A	IMST	High	ES : Ready, MP : Q4'20
NFAP1060L3TT	600V	10A	IMST	High	MP
NFAP1560L3TT	600V	15A	IMST	High	TBD

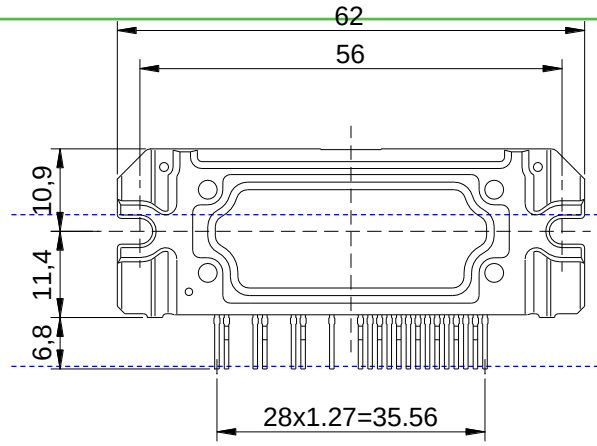
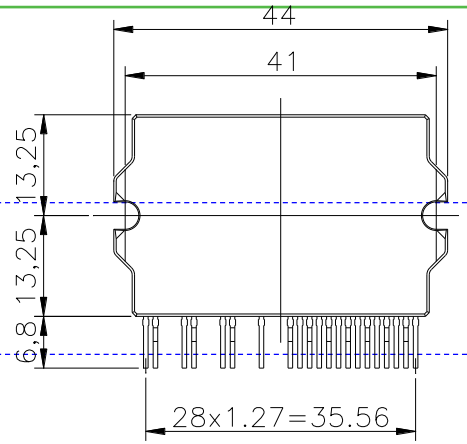
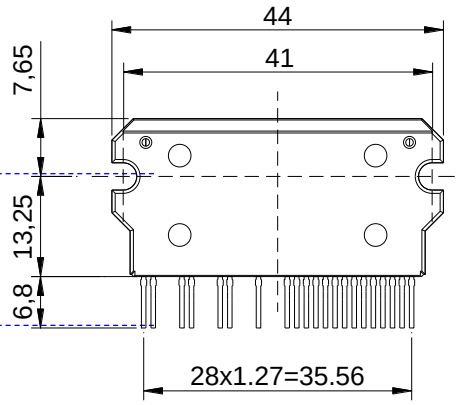
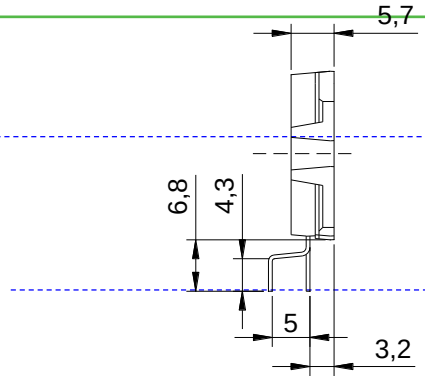
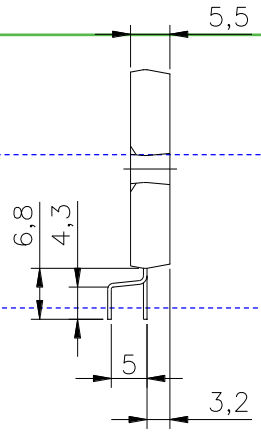
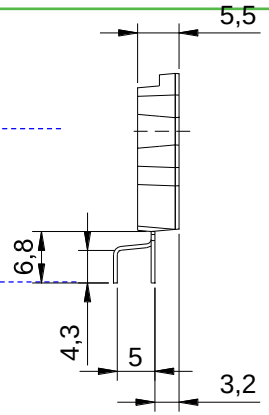
内部设计



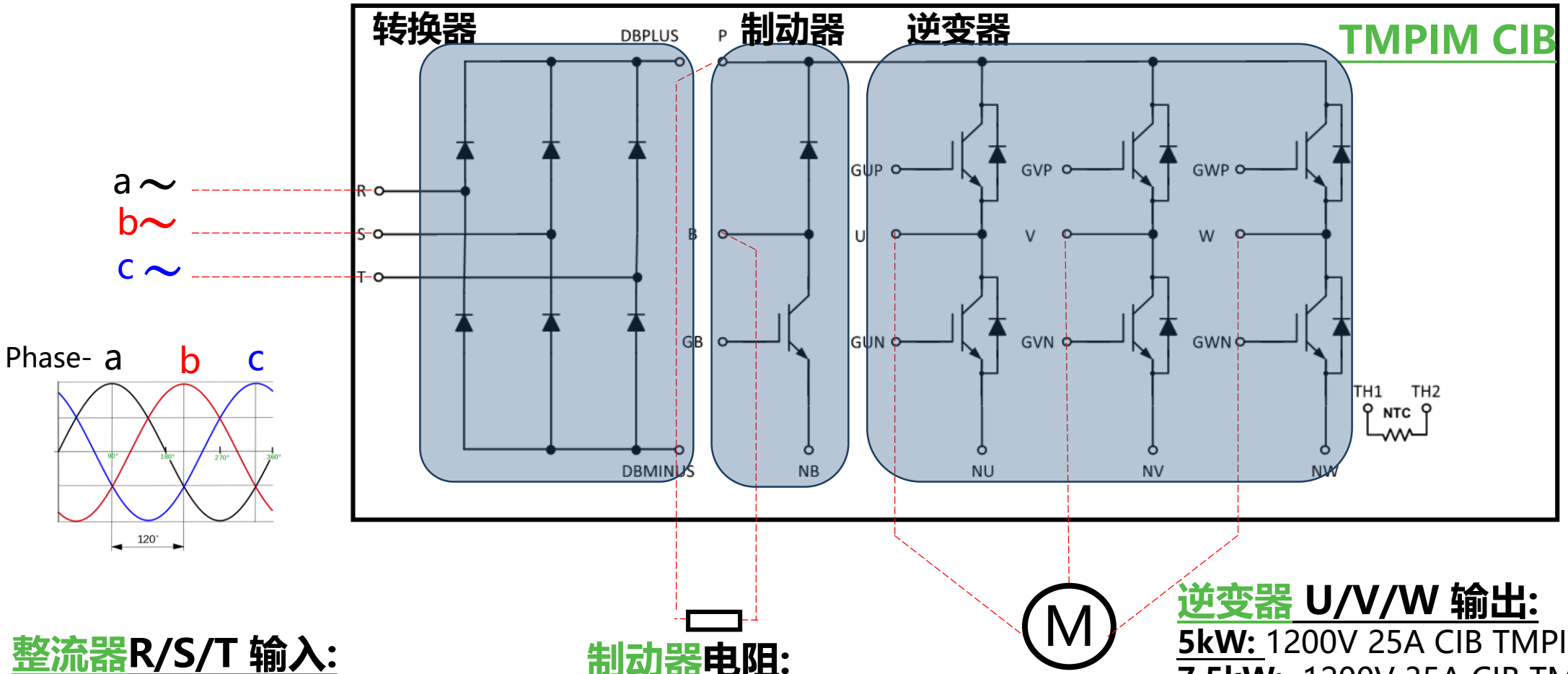
应用

- Industrial Fan Motor Applications
- Consumer Applications

SIP-K封装尺寸

	SIP1A (现在的: STK554U362C-E)	SIP05 (STK534U362C-E)	SIPK (NFAP1060L3TT)
封装尺寸 [mm]	62 x 22.3 x 5.7	44 x 26.5 x 5.5	44 x 20.9 x 5.5
前视尺寸			
侧视尺寸			

TMPIM CIB电源模块的应用示意图



整流器R/S/T 输入:

3-phase ~ 240V: 650V CIB TMPIM

3-phase ~ 400V: 1200V CIB TMPIM

制动器电阻:

当电机减速/停止时控制总线电压

逆变器 U/V/W 输出:

5kW: 1200V 25A CIB TMPIM (released)

7.5kW: 1200V 35A CIB TMPIM (released)

10kW: 1200V 50A CIB TMPIM (released)

15kW: 1200V 75A CIB QLP (coming soon)

20kW: 1200V 100A CIB QLP (coming soon)

转模成型功率集成模块(TMPIM)

凝胶填充功率集成模块

竞争器件A

竞争器件C

竞争器件B

PIM

凝胶填充模块	参数	ON TMPIM
1x	功率循环	3x ↑↑↑
1x	温度循环	10x ↑↑↑
较低	能效	更高
不密封	耐腐蚀	好

转模成型功率集成模块

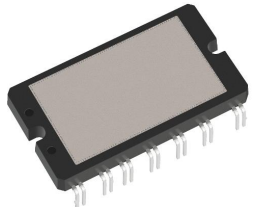
DIP-26

QLP-74

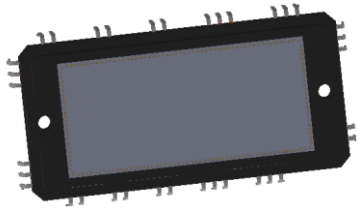
TMPIM
DIP/QLP

功率

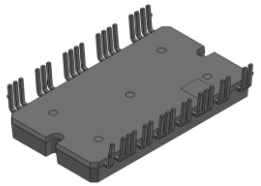
高可靠性、高功率TMPIM



600 V ~1200 V
25 A ~ 50 A C-I-B



600 V ~1200 V
75 A ~ 100 A C-I-B



> 200 A 标准的

2019 2020 2021 年

特性

- **转模成型**
  - 使用寿命长
  - 强固
  - 耐腐蚀
- **先进的基板**
  - 省去底板！
  - 重量轻，紧凑
- **工艺简单**
  - 性价比高
  - 客户设计灵活
- **全功率阵容**
  - 宽功率范围选择

TMPIM标准模块产品路线

高可靠性，高功率密度

功率等级

20KW

10KW

Topology	Package	1200V				650V				
		25A	35A	50A	75A	35A	50A	75A	100A	150A
CIB	DIP-26	x	x				x			
	Enhanced DIP-26		x	x		x	x	x		
CI	DIP-26		x				x			
	Enhanced DIP-26			x			x	x		
6-pack	DIP-26						x			
	Enhanced DIP-26			x	x		x	x	x	x

已发布

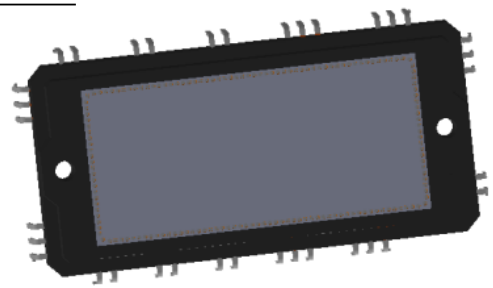
发布

3.75 kW ~ 10 kW 驱动: DIP-26

. 提供标准的和增强的平台
. 双列直插式封装
. 提供650 V 版本和1200 V版本
. 拓扑: CIB, CI, 6pack, PFC

10kW ~ 20kW 驱动: QLP-74

. 提供标准的和增强的平台
. 4引线框架封装
. 提供650V版本和 1200 V版本
. 拓扑: CIB, CI, 6pack, PFC

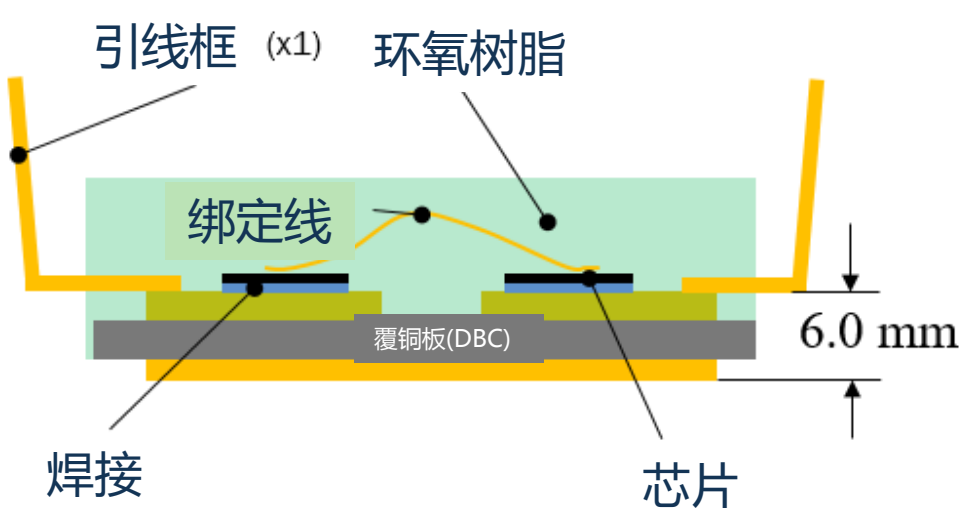


Topology	Package	1200V		650V	
		75A	100A	100A	150A
CIB	QLP-74 (Enhanced)	x	x	x	x

H1′ 20　　H2′ 20　　H1′ 21

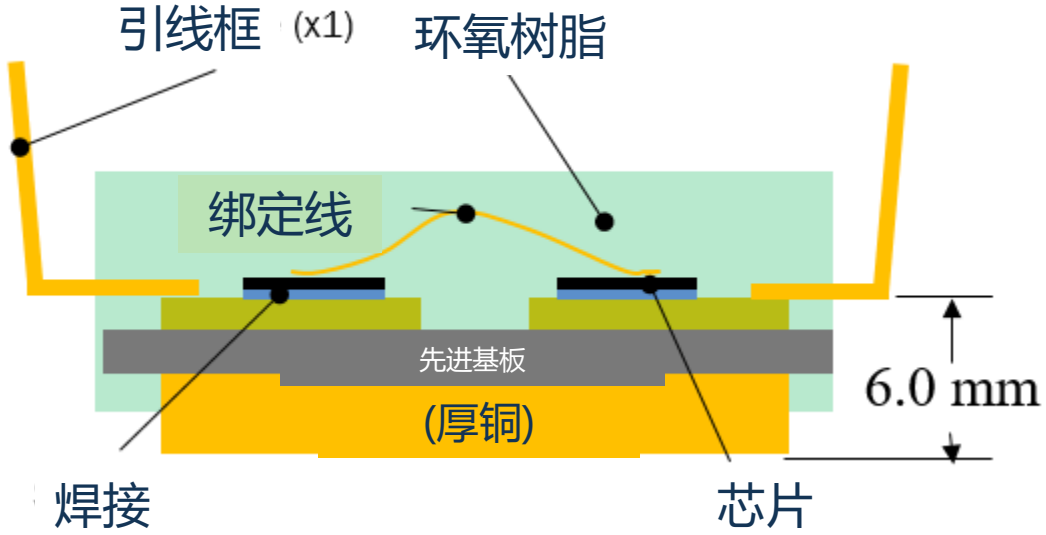
TMPIM标准型和增强型内部结构

标准的TMPIM



相同的
引出线
外形
尺寸

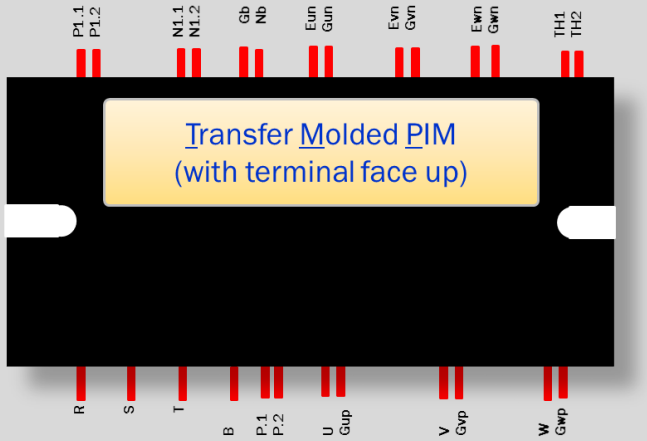
增强的TMPIM

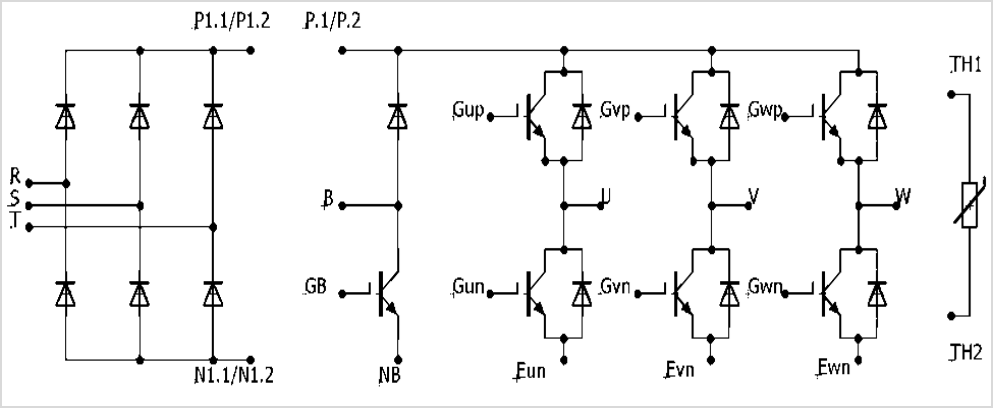


DIP-26 CIB/CI电源模块

特性

- 输入端子和输出端子在同一侧以易于接线
- DC + 和 DC- 跨越模块宽度以最小化连接的寄生效应
- 拓扑具有宽功率范围，享有相同的引脚排列，易于系统功率的提升





引脚间距:

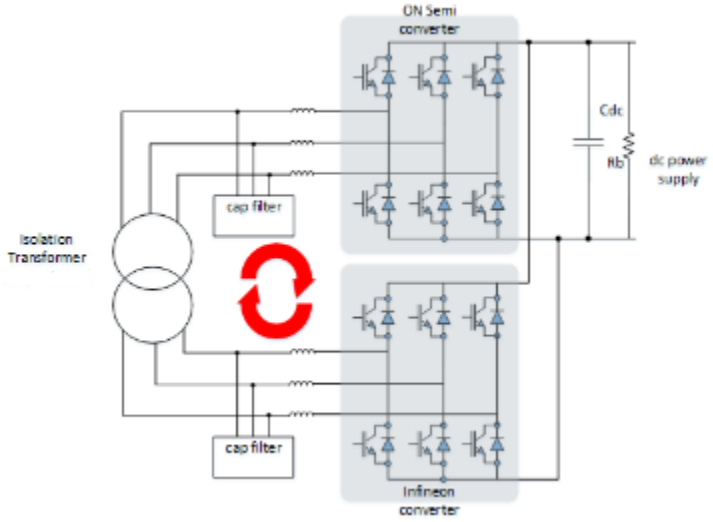
引脚名	引脚名	间距要求	实际距离 **
+ Pin before Inrush	+ Pin after Inrush	1.5mm	>10.0 mm
+ (or Positive Pin)	U, V, W /B	2.6mm	5.4 mm
U, V, W	U, V, W	2.5mm	5.4 mm
R, S, T	R, S, T	5mm	5.4 mm
R, S, T	Pin or Negative Pin	5mm	5.4 mm
Any Pins	Heatsink	5.5mm	6.0 mm
Any Pins	NTC	5.5mm	7.9 mm

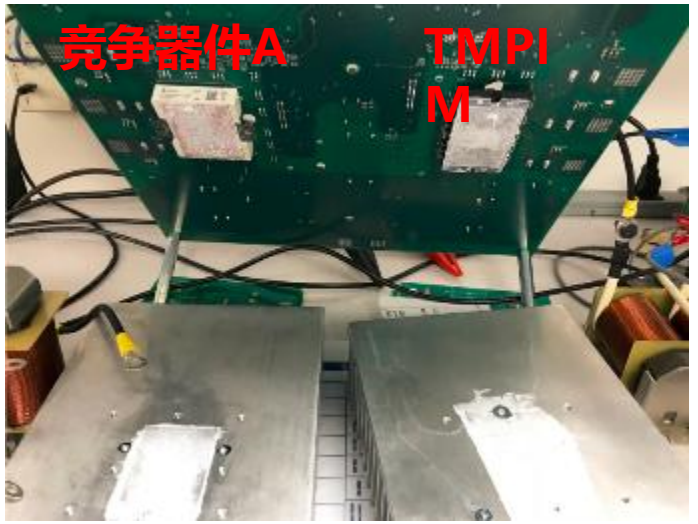
	Pin Name	P1 .1	P1.2	N1.1	N1.2	GB	NB	Eun	Gun	Evn	Gvn	Ewn	Gwn	TH1	TH2
Side A	Pin width (mm)	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
	Coodination	0	2.54	10.16	12.7	17.78	20.32	27.94	30.48	38.1	40.64	48.26	50.8	60.96	63.5
	Pin 2 pin clearance (mm)		0.3	5.4	0.3	2.8	0.3	5.4	0.3	5.4	0.3	5.4	0.3	7.9	0.3
Side B	Pin Name	R	S	T	B	P.1	P.2	U	Gup	V	Gvp	W	Gwp		
	Pin width (mm)	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2		
	Coodination	0	7.62	15.24	22.86	30.48	33.02	40.64	43.18	50.8	53.34	60.96	63.5		
	Pin 2 pin clearance (mm)		5.4	5.4	5.4	5.4	0.3	5.4	0.3	5.4	0.3	5.4	0.3		

** 距离考虑了焊盘的直径(mm):
[引脚宽度*引脚宽度+引脚厚度*引脚厚度] +钻孔公差+焊盘宽度的平方根

功率循环测试

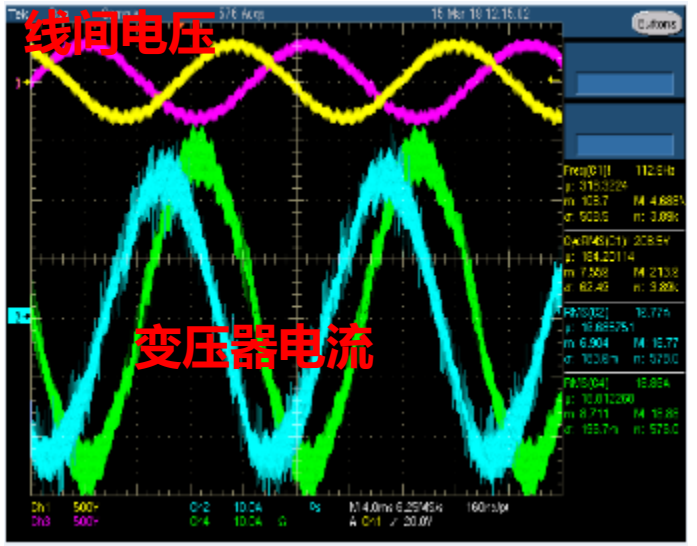
- 构建功率回环系统以进行TMPIM特征和性能对比
- 7 KW 回环系统采用TMPIM-35 A 模块和竞争对手的35 A 模块
- TMPIM的散热器温度及壳温优于竞争器件
  - 更快的开关有利于降低Eoff 损耗
  - TMPIM 因快速开关IGBT及快恢复二极管特性，提供更高能效
  - TMPIM的更低 Rth(°C/W) 降低散热器温度



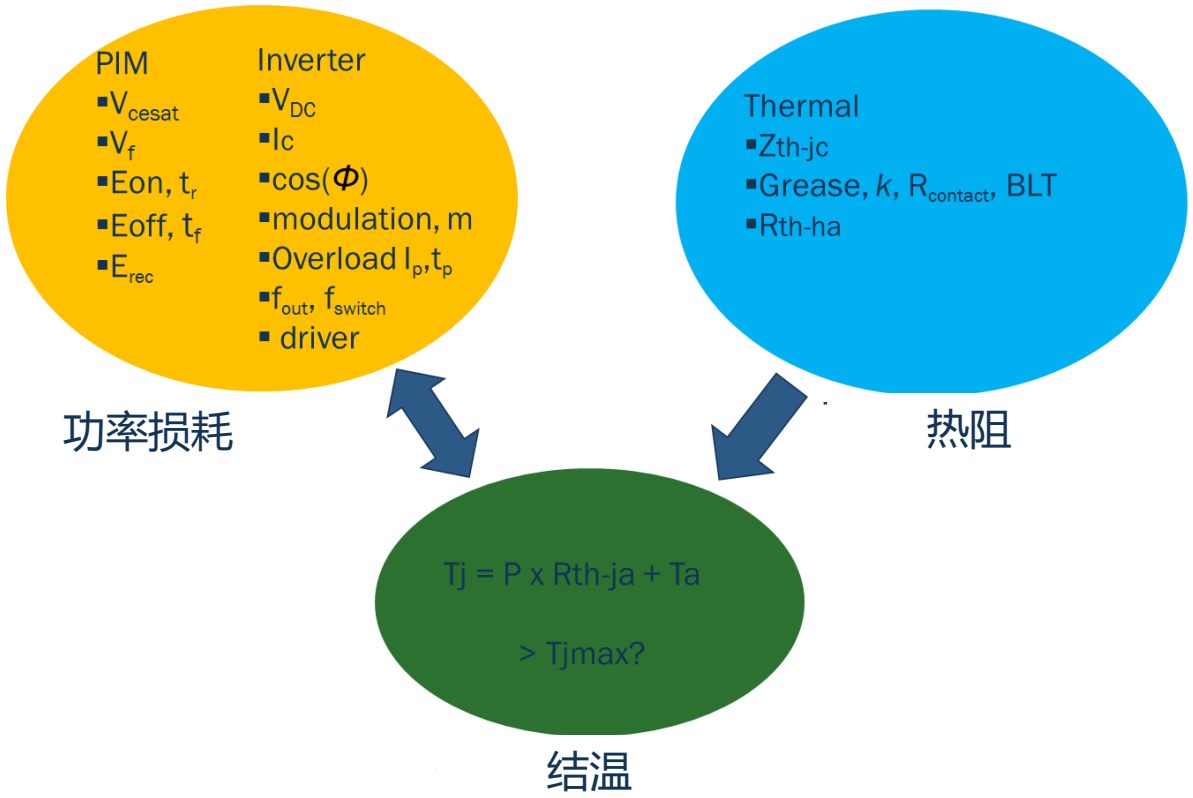


	TMPIM	竞争器件A
环境温度(°C)	23.7	23.7
散热器温度(°C)	59.3	62.3

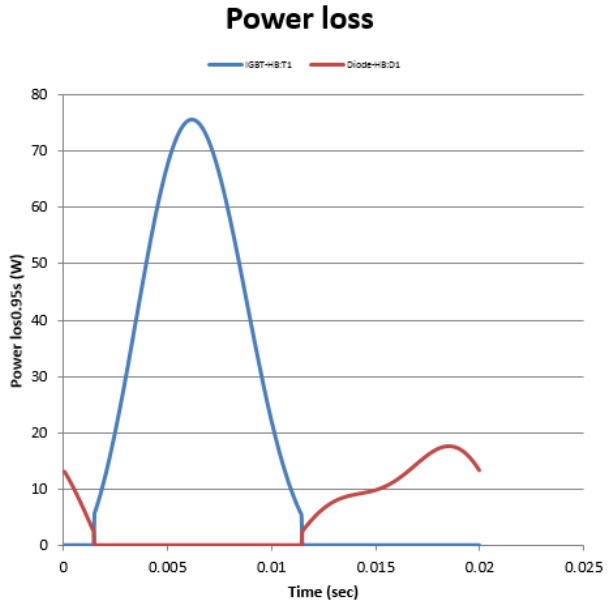
条件
Vdc = 600V, fsw = 6.5kHz, Vout = 230V(Vrms); Iout = 17.5Arms, PF = 1

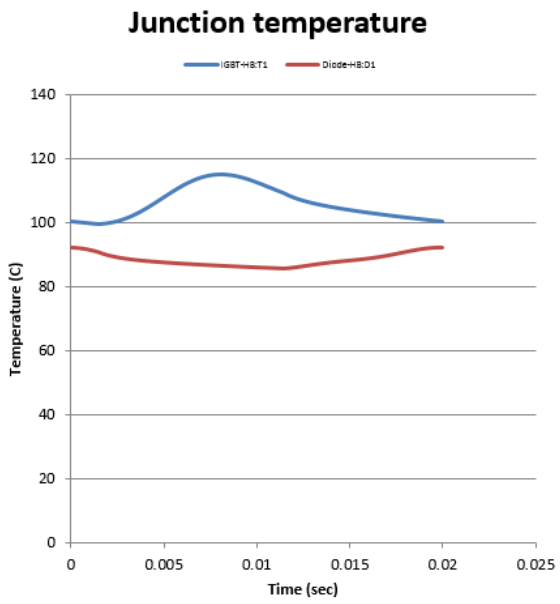


功率损耗及热仿真

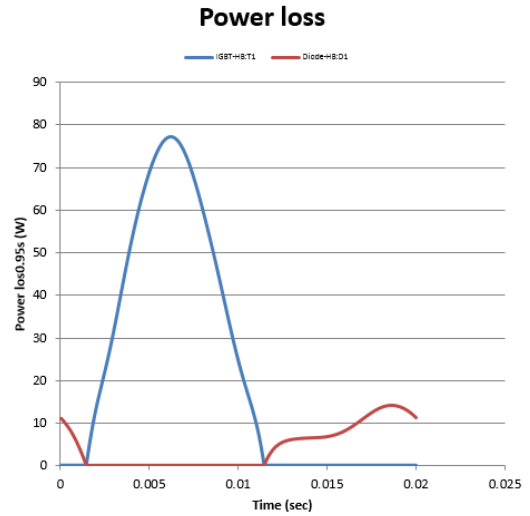


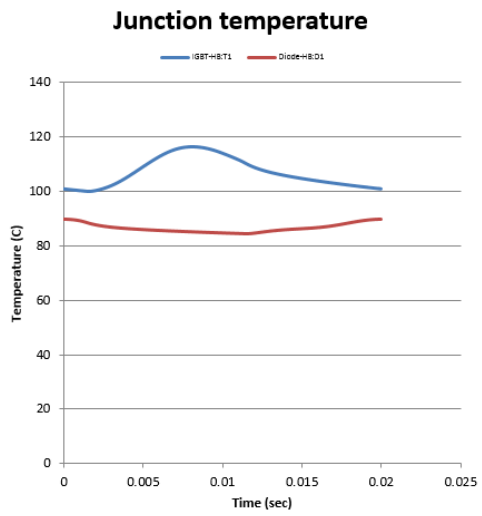
TMPIM 在功率损耗和能效表现出高性能!





竞争器件在相同条件下

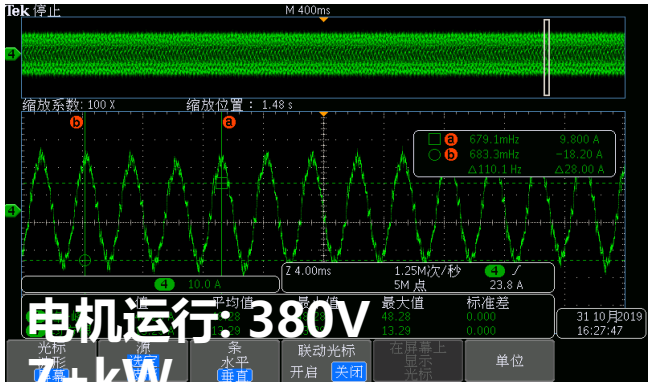


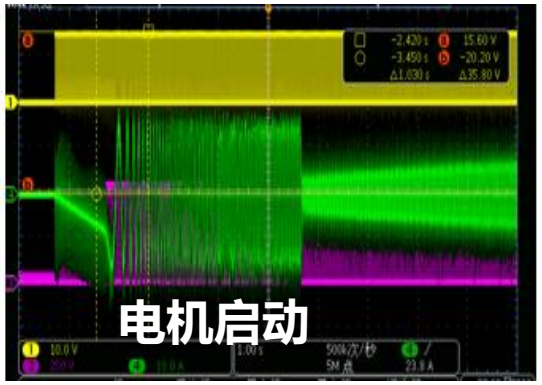


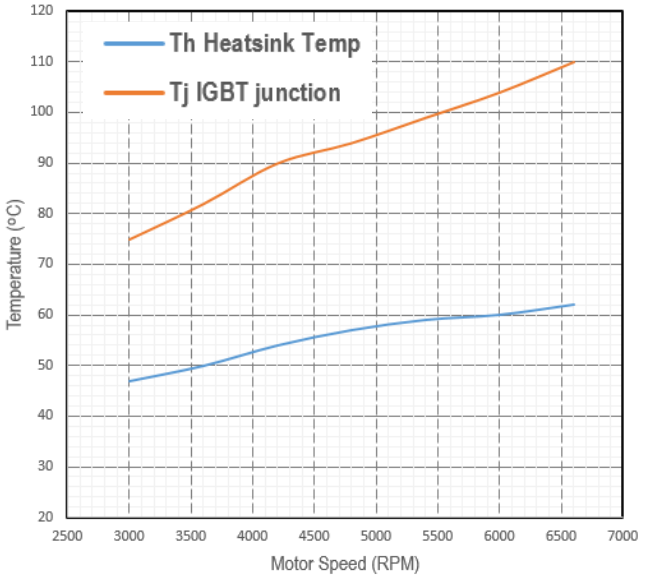
电机测试和客户反馈

波形和温度

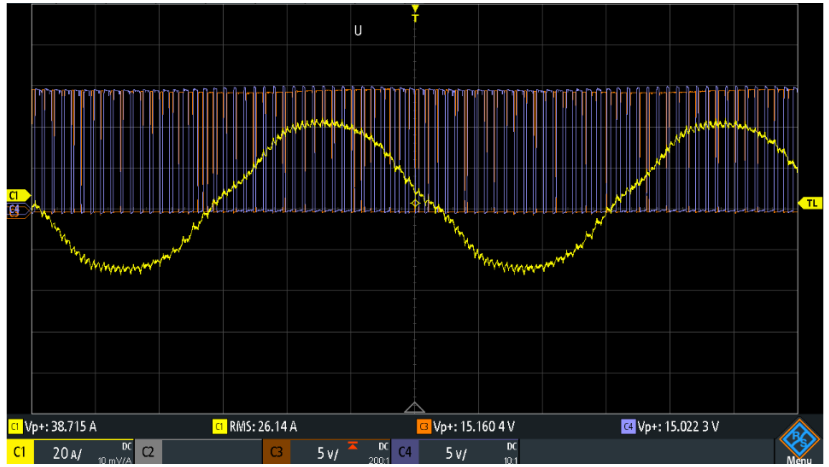
1200 V 35 A CIB: NXH35C120L2C2SG







1200 V 50 A CIB: NXH50C120L2C2ESG

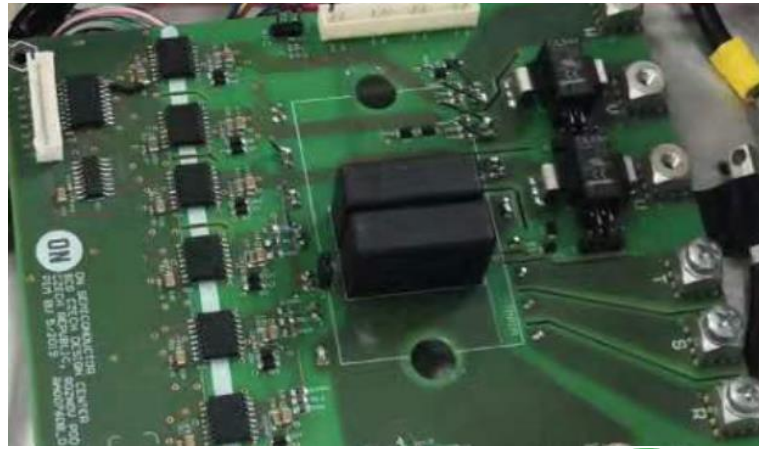


在客户系统中高负载条件下持续工作达20 kW以上

$T_{heatsink}$ = 90 °C

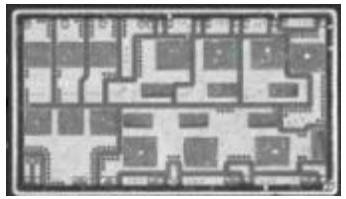
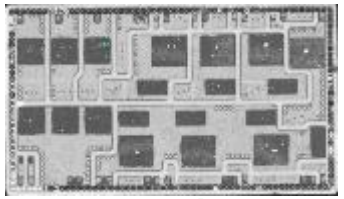
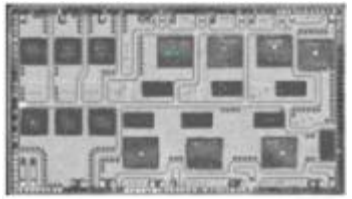
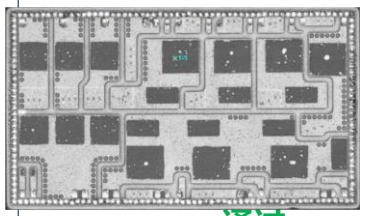
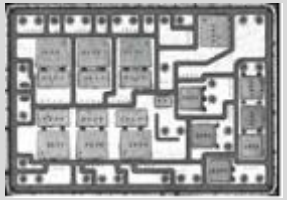
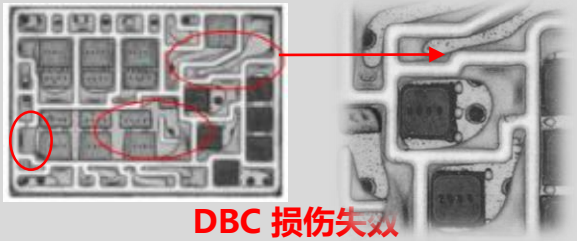
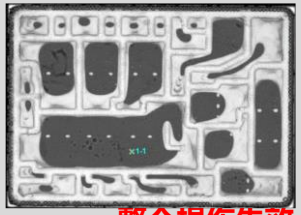
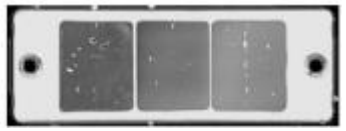
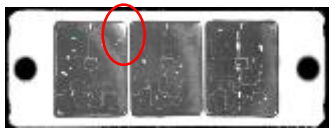
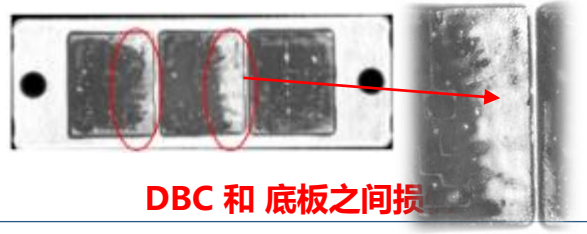
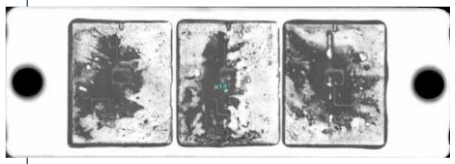
T_{NTC} = 110 °C

为评估TMPIM 电源模块, 请到 www.onsemi.cn 下载电源及驱动器 PCB 板参考设计

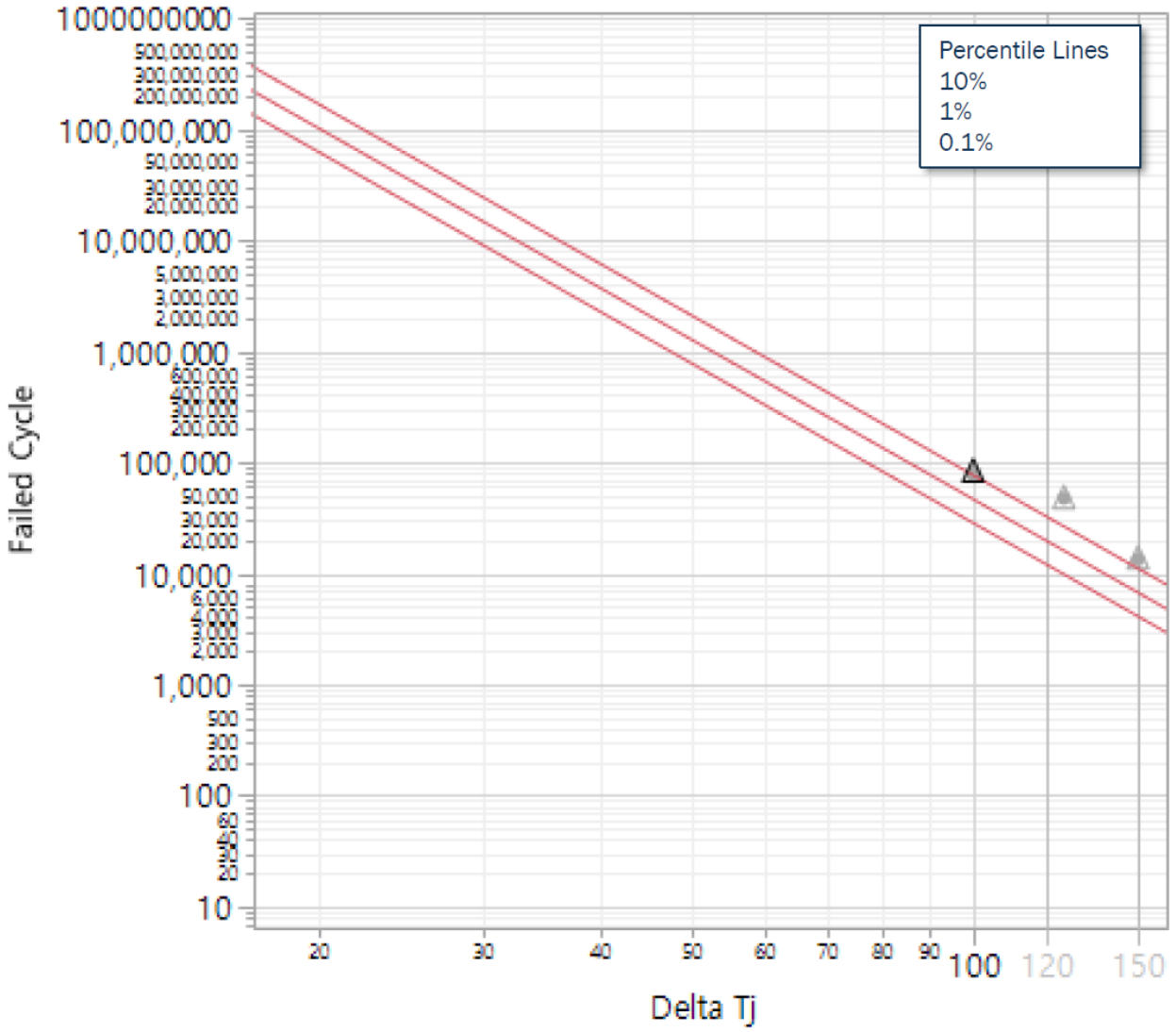


温度循环寿命

- 同等对比: 温度循环达1000个周期.
- 测试条件: -40 ^{0}C ~ 125 ^{0}C

封装	器件 #	TC @ 0 个周期	TC @ 100个周期	TC @ 500个周期	TC @ 1000个周期
TMPIM	NXH35C120L2C2SG		 通过	 通过	 通过
凝胶填充模块	竞争器件A		 DBC 轻微损伤	 DBC 损伤失效	 整个损伤失效
带底板的凝胶填充模块	竞争器件B		 焊接损伤	 DBC 和 底板之间损	 跨模块失效

TMPIM使用寿命图



方法	线性模式，带水冷散热器
样品尺寸	4pcs for each Delta Tj
Ion	19A
Ton	4sec
温度范围	Delta Tj 100C (25C ~ 125C)
	Delta Tj 125C (25C ~ 150C)
	Delta Tj 150C (20C ~ 170C)

- β (Shape Parameter) : 4.69, Wear-out failure mode (β > 1)
- η (Scale Parameter): # of cycle till getting 62.3% failures
  124,980cyc @ 100C
  43,039cyc @ 125C
  18,013cyc @ 150C

*** Equation
η = exp(33.73679)X(delta Tj)^(-4.77743)
Using Coffin-Manson Modeling

质量标准

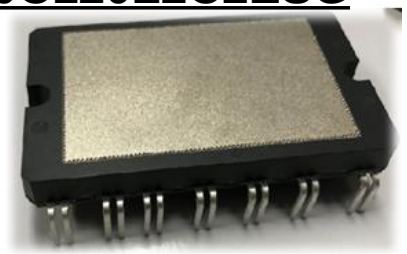
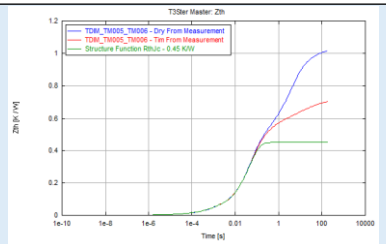
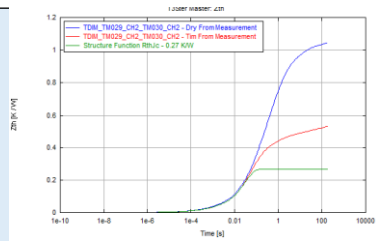
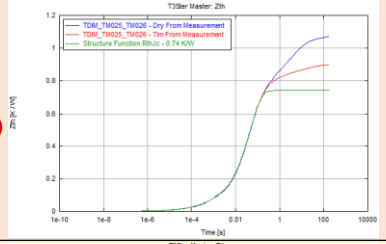
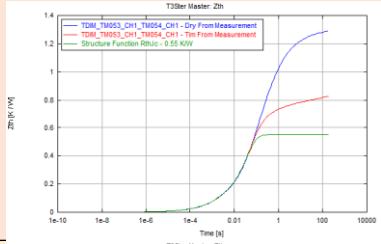
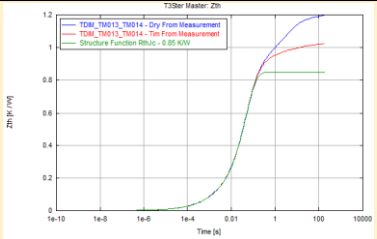
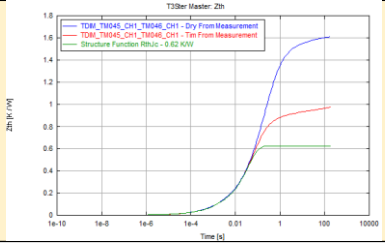
测试全通过

TMPIM模块质量标准的测试项和记录.

Test	Name	Test Conditions	End Point Req's	Test Results	(rej/ ss)	(rej/ ss)	(rej/ ss)	(rej/ ss)	(rej/ ss)	(rej/ ss)	(rej/ ss)
				Read Point	Lot A	Lot B	Lot C	Lot D	Lot E	Lot G	
Prep	Sample preparation and initial testing	various	---	Initial Electrical	done	done	done				N.A
HTRB	High Temp Reverse Bias	Tj = 150 ℃ for 1,008 hours	c = 0, Room	Initial	0/12	0/12	0/12	0/12	0/12	0/12	N.A
RRF#K57314		90% BV of max rating (Inverter Part)									
		Tj = 125 ℃ for 1,008 hours									
		66% BV of max rating (Rectifier Part)		504 Hrs	0/12	0/12	0/12	0/12	0/12	0/12	N.A
				1008 Hrs	0/12	0/12	0/12	0/12	0/12	0/12	N.A
H3TRB	High Temperature, Humidity, Bias	Ta = 85 ℃, 85%RH for 1,008 hours	c = 0, Room	Initial	0/12	0/12	0/12	0/12	0/12	0/12	N.A
RRF#K57314		80% BV of max rating (Inverter Part)									
		Ta = 85 ℃, 85%RH for 1,008 hours									
		100V (Rectifier Part)		504 Hrs	0/12	0/12	0/12	0/12	0/12	0/12	N.A
				1008 Hrs	0/12	0/12	0/12	0/12	0/12	0/12	N.A
Reflow	Reflow	Tp=210C x 3	c = 0, Room	Initial	0/77	0/77	0/77				N.A
RRF#K57314				**X 3**	0/77	0/77	0/77				N.A
HTSL	High Temperature Storage Life	Ta=150 ℃ for 1,008hrs	c = 0, Room	Initial	0/12	0/12	0/12				N.A
RRF#K57314				504 Hrs	0/12	0/12	0/12				N.A
				1008 Hrs	0/12	0/12	0/12				N.A
THU	High Temperature Humidity	Ta = 85 ℃, 85%RH for 1,008 hours	c = 0, Room	Initial	0/12	0/12	0/12				N.A
RRF#K57314		No Bias									
				504 Hrs	0/12	0/12	0/12				N.A
				1008 Hrs	0/12	0/12	0/12				N.A
VVF	Vibration	25-500Hz/15min, 10G, each 2 hours X, Y, Z	c = 0, Room	Initial	0/5	0/5	0/5				N.A
RRF#K57314											
				6hrs	0/5	0/5	0/5				N.A
PCT	Power Cycle	Delta 100C, 10kcyc	c = 0, Room	Initial	0/4	0/4	0/4				N.A
RRF#K57314				**10,000 cyc**	0/4	0/4	0/4				N.A
TC	Temperature Cycle	-40/+125 C	c = 0, Room	Initial				0/79	0/79	0/79	N.A
RRF#K57314				100 cyc				0/79	0/79	0/79	N.A
				1000 cyc				0/79	0/79	0/79	N.A
LTSL	Low Temperature Storage Life	Ta=-40 ℃ for 1,008hrs	c = 0, Room	Initial	0/12	0/12	0/12				N.A
RRF#U60593											
				1008 Hrs	0/12	0/12	0/12				N.A
BPS	Bond Pull Strength		Cpk >1.67	Results	0/1	0/1	0/1				N.A
BS	Bond Shear		Cpk >1.67	Results	0/1	0/1	0/1				N.A
ESD	Electro-static Discharge	Human Body Model (HBM), Charge Device (CDM)		Results	3pcs for each CDM/HBM 'Refer to Page 3 ESD result'						N.A

低热阻

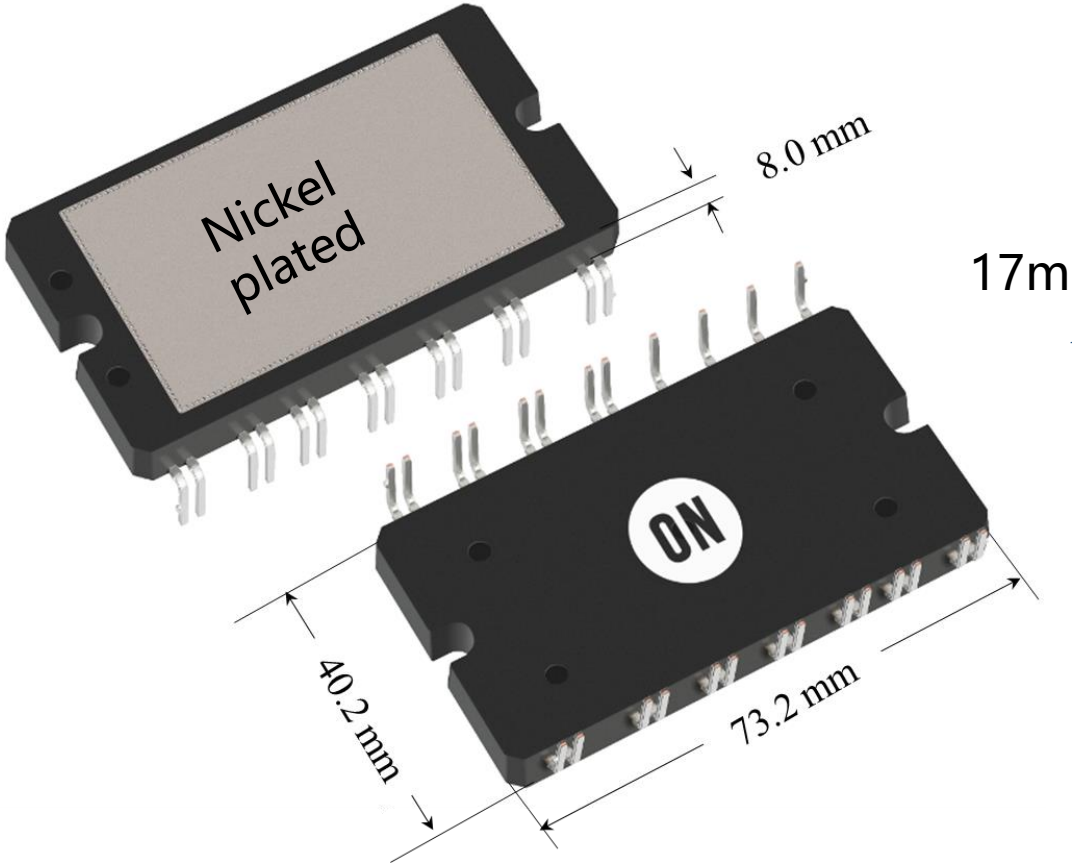
采用先进的厚铜基板, 模块热阻可提高达30%.

Rth JC (K/W) **	竞争器件B 		NXH50C120L2C2ESG 	
IGBT 逆变器	0.43		0.27	
二极管逆变器	0.735		0.54	
整流器	0.825		0.62	

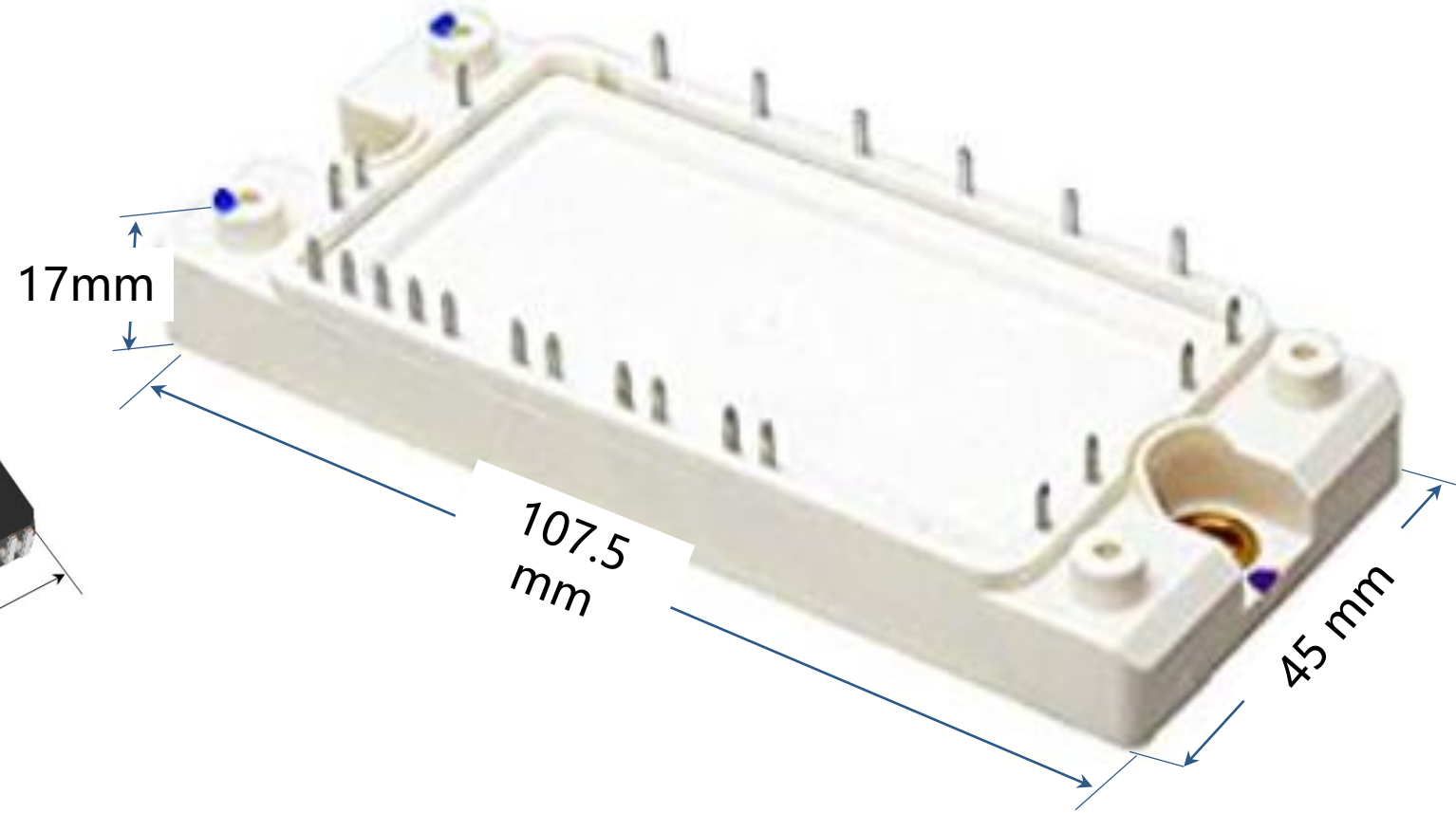
** Thermal characterization test acc. to JEDEC51-14 IGBT

高功率密度

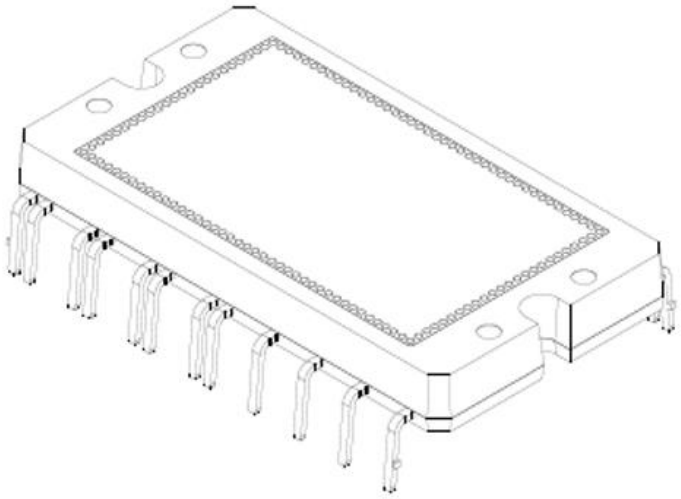
TMPIM 1200 V 50 A CIB 模块
体积: 35311 mm^3 (竞争器件 B的体积的**43%**)

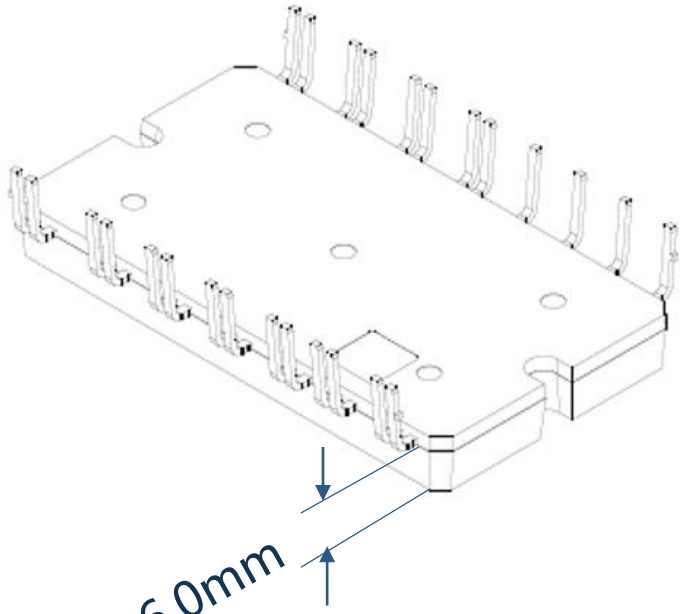


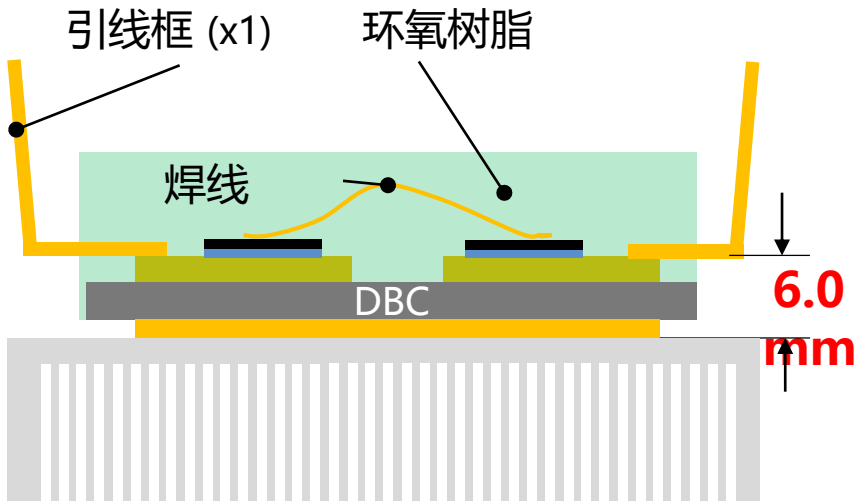
竞争器件 B 1200 V 50 A CIB 模块体积: 82237 mm^3



标准及认证



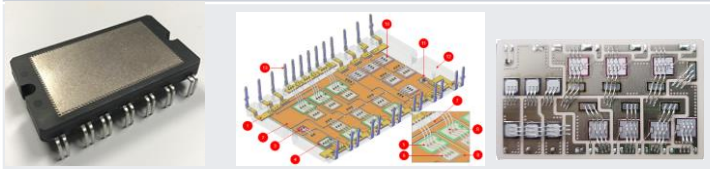


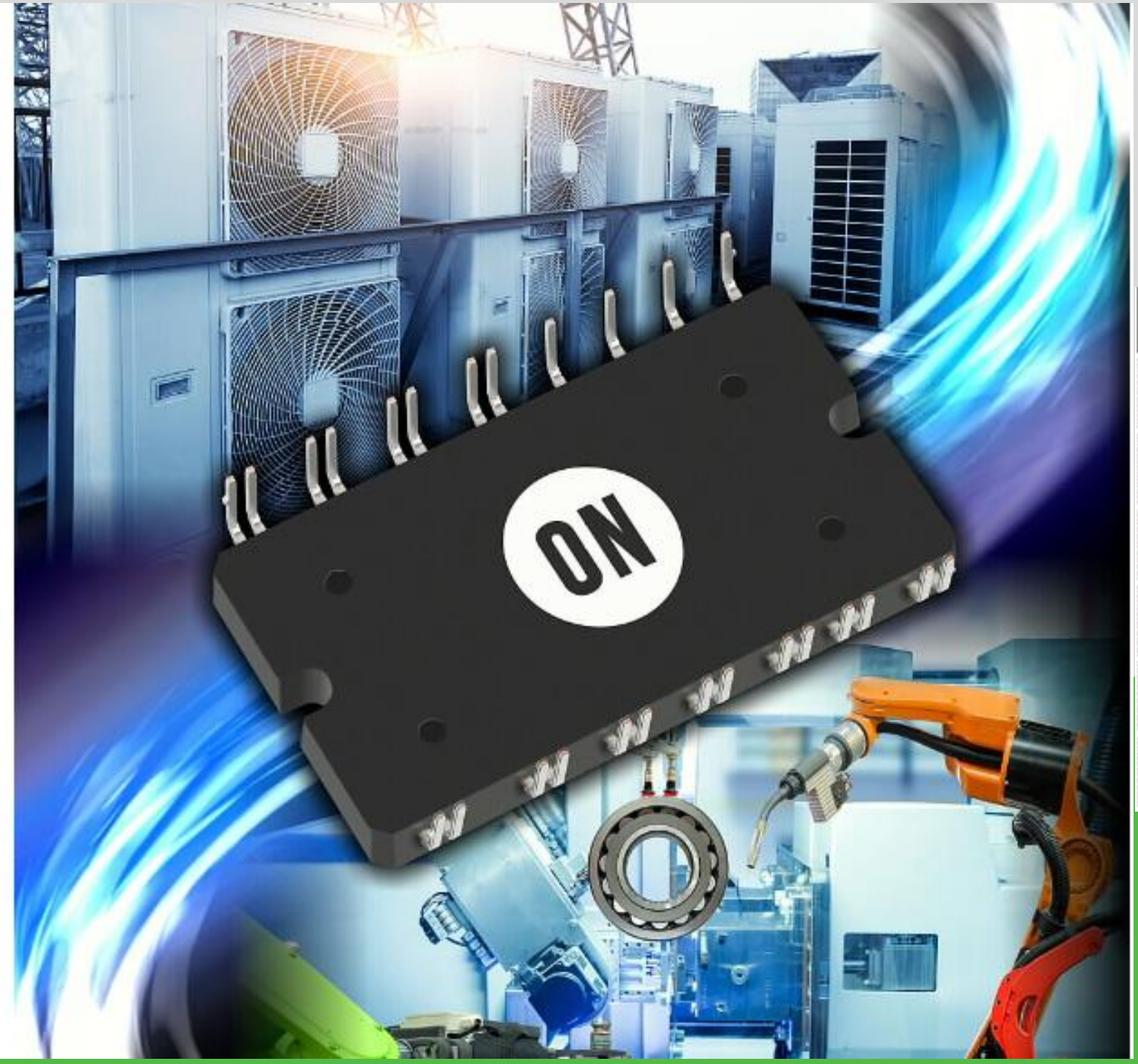


1200V TMPIM 模块旨在满足 IEC61800-5-1 (VFD drive) 要求
引脚与散热器的电气间隙 : 6mm
CTI : 600

符合UL 认证，且 100% 产品线测试
符合UL1557 标准
UL 认证 efile: E468801

TMPIM DIP-26 CIB总结

		凝胶填充模块	TMPIM	
转换器-逆变器-制动器模块		Comp-A: 1200V 25A/35A (maximum 35A)	DIP-26 1200V 25A/35A/50A	
		 封装97 个器件	 封装28 个器件	
描述	平台技术 外形尺寸 基板面积	*凝胶填充* *62.8mm x 56.7mm x 12.0mm* *2,117 mm²*	*转模成型* *73mm x 47mm x 8.0mm* *2,135 mm²*	
电气性能	整体能效 Vcesat 短路 (µs)	*好* *2.15 V* *10*	*好或更好* *2.1 V* *10*	✓
热性能	热阻	*好*	*好或更好*	✓
机械	强固性 贴装高度	*好* *12.0 mm*	*好或更好* *12.0 mm*	✓
可靠性	温度循环 (Cyc) 功率循环 (Cyc)	*100* *20,000*	*1,000* *60,000*	✓
安全标准 **IEC61800-5-1**	电气间隙 爬电距离 隔离电压	*5.0mm* *6.3mm* *3,000 V*	*6.0mm* *6.0mm* *3,000 V*	✓



发布的产品

OPN	Rating	Configuration
NXH25C120L2C2SG	1200V 25A	C-I-B
NXH35C120L2C2SG	1200V 35A	C-I-B
NXH35C120L2C2S1G	1200V 35A	C-I
NXH35C120L2C2E SG	1200V 35A	enchance C-I-B
NXH50C120L2C2E SG	1200V 50A	C-I-B
NXH50C120L2C2E S1G	1200V 50A	C-I

Parts Released!

Look for product information:
www.onsemi.com

创新TMPIM产品助力工业驱动控制

- 安森美半导体**推出了**创新的TMPIM功率模块平台，CIB 模块产品线集成3相转换器、逆变器和制动器。在采用最佳的 IGBT/FRD 技术下, 具备良好的能效和强固性，极其**适用于电机驱动器和暖通空调(HVAC)应用**
- TMPIM 采用创新工艺, 可靠的基板和环氧树脂转模成型技术, 比普通的凝胶填充电源模块热循环使用寿命提高10倍，功率循环使用寿命提高3倍。它将**助推客户终端逆变器系统长的使用寿命及高可靠性**
- 该模块采用先进的厚铜基板，省去底板，比普通模块减小57%的体积，且提高30%的热阻，大大 **增加功率密度**
- 该模块用环氧树脂模塑密封，背面镀镍，可**防止**铜垫之间**形成枝晶**，适合在某些腐蚀气体工作环境下工作
- 该模块符合 IEC61800-5-1 标准，**引脚与散热器电气间隙6mm**，且符合UL1557 标准(E608861)

谢谢大家!

专家答疑Q&A