

onsemi 大功率PIM模块在光伏和储能的应用

Allen Zhang, Nov 2023

Agenda :

1

光伏市场的现状和趋势

2

PIM模块的优势以及相关拓扑

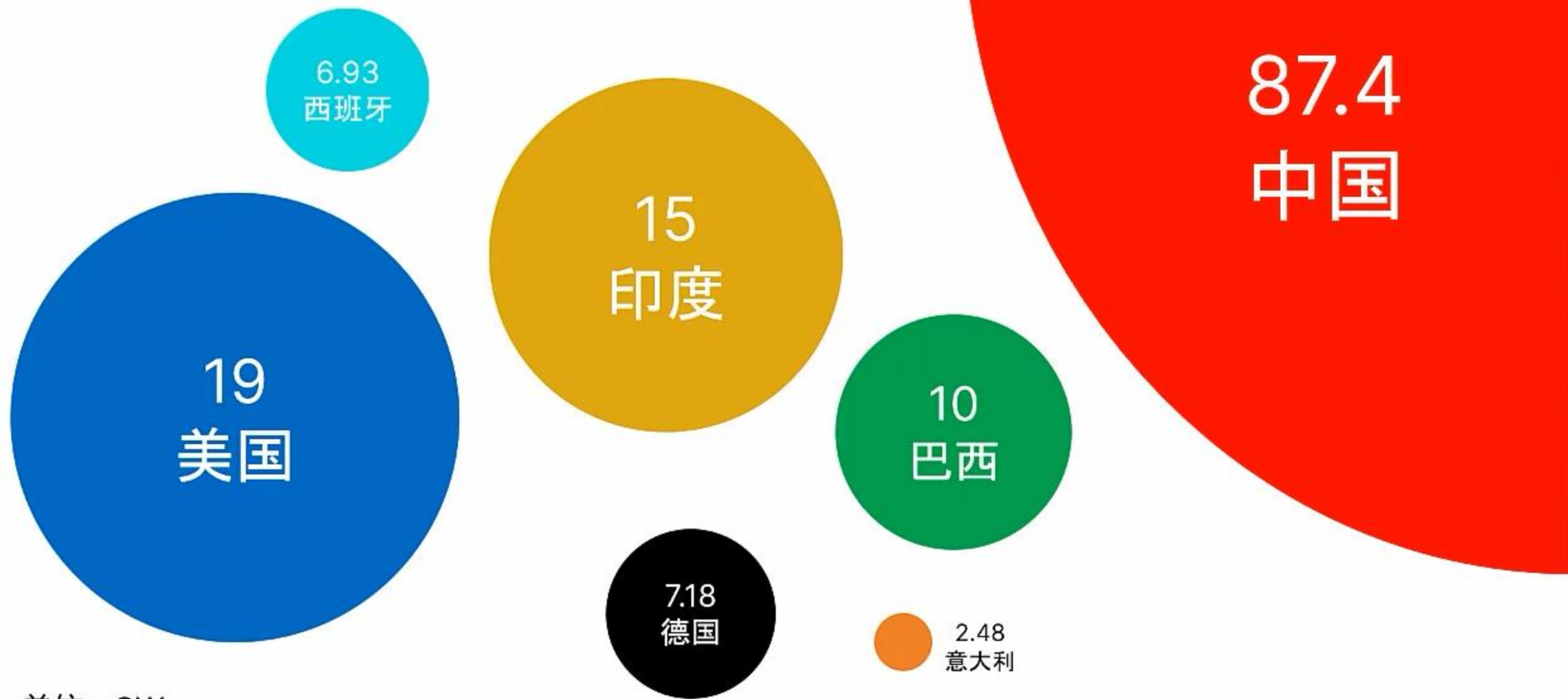
3

onsemi 光伏模块和解决方案

4

onsemi 储能模块和解决方案

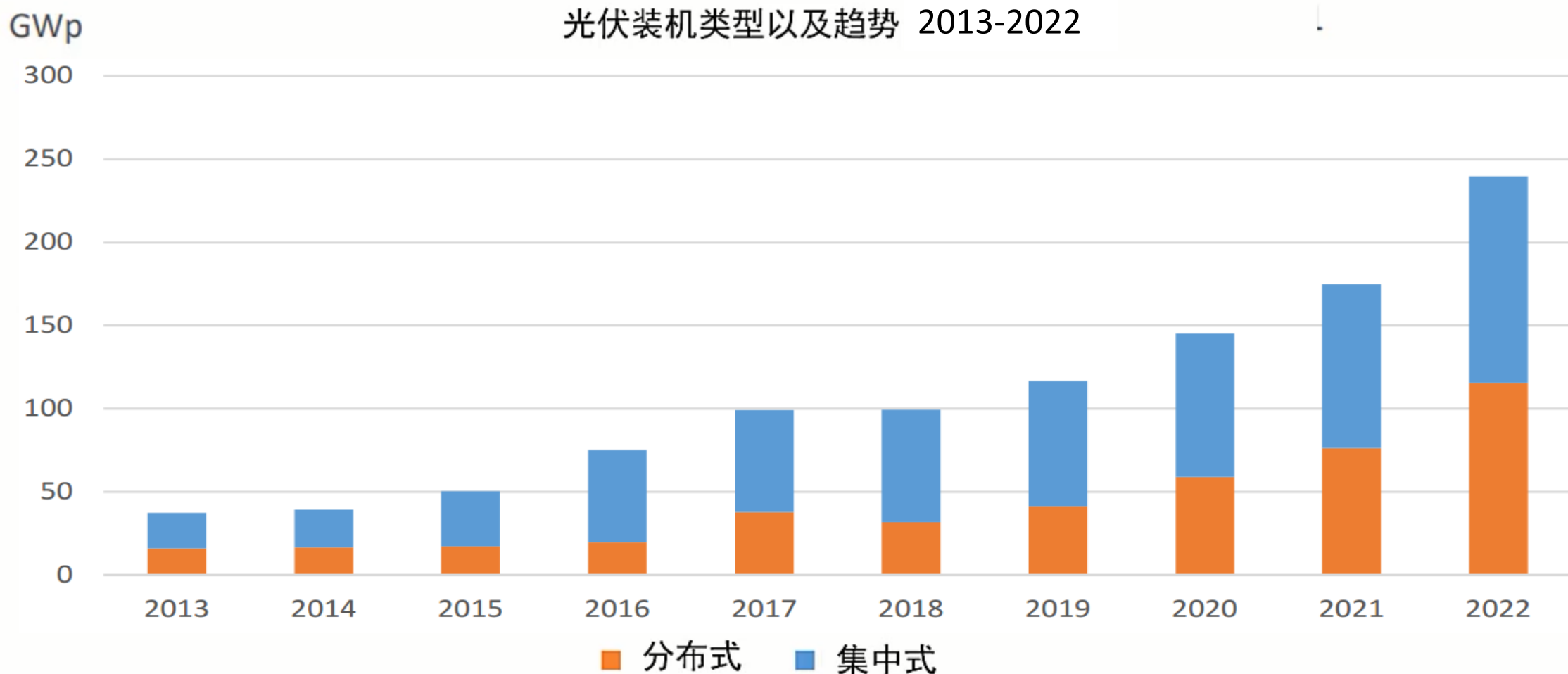
2022年度全球光伏装机量一览



单位: GW

数据来源: PV Magazine

光伏逆变器的趋势



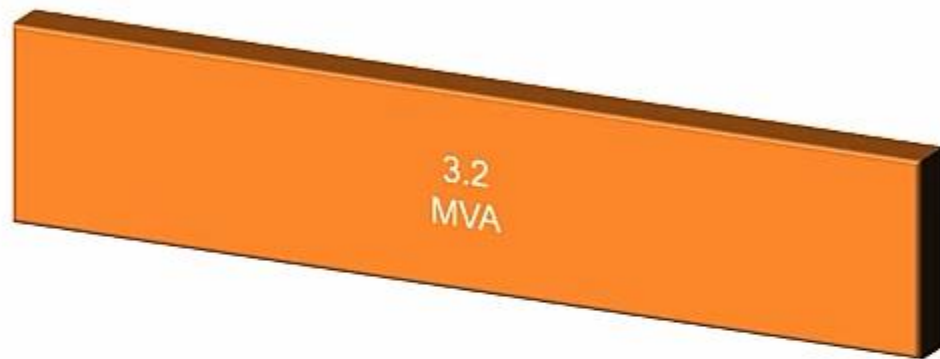
数据来源：国际能源署光伏组织(IEA-PVPS)，2023Q2

组串式逆变器 vs. 集中式逆变器

- 集中式逆变器

- 适用于大型发电项目
- 功率大、数量少、稳定性高、易维护
- 安装地点、方式要求高
- 自身耗电以及散热通风耗电大
- MPPT电压范围窄，无法最优发电

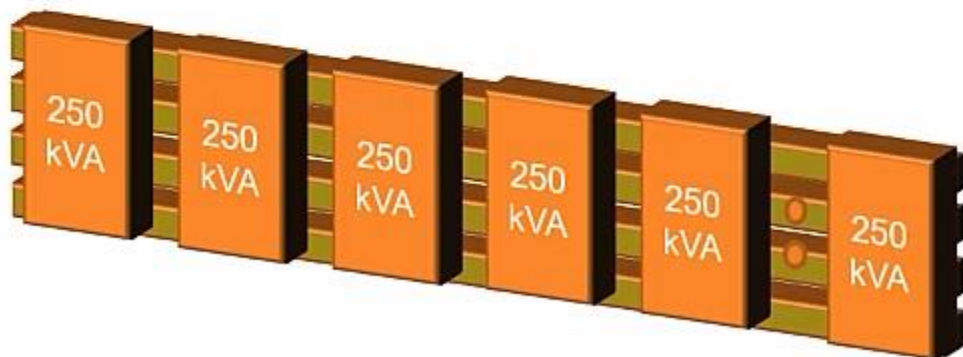
集中式逆变器- 1 × 3.2 MVA



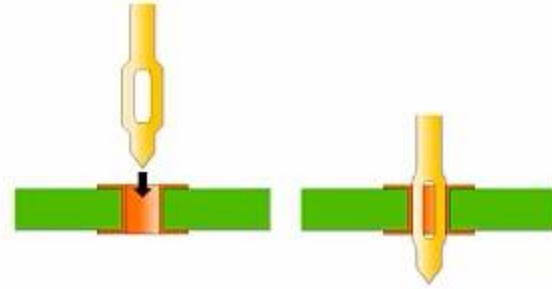
- 组串式逆变器

- 适用于户用、商用场景
- 安装灵活、更多MPPT路数，发电效率高
- 成本低，易拓展
- 更多器件、较高总体故障率

组串式逆变器- 10 × 320 kW / 13 × 250kW



PIM模块对单管的优缺点

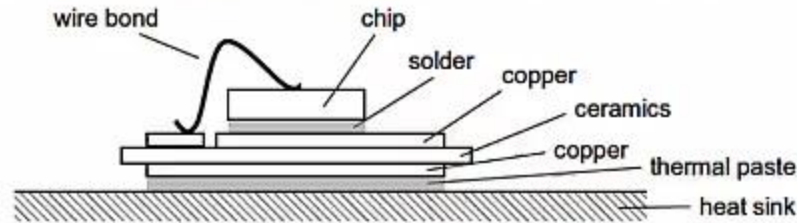


PIM模块优势:

1. PCB设计方便
2. 减少PCB空间
3. 生产方便
4. 散热能力好
5. 绝缘能力强
6. 一致性好
7. 可靠性高
8. 寄生效应

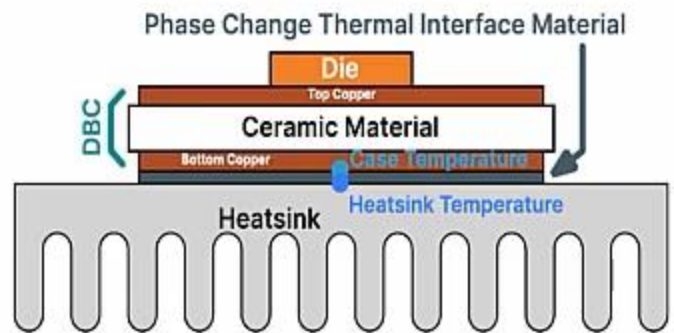
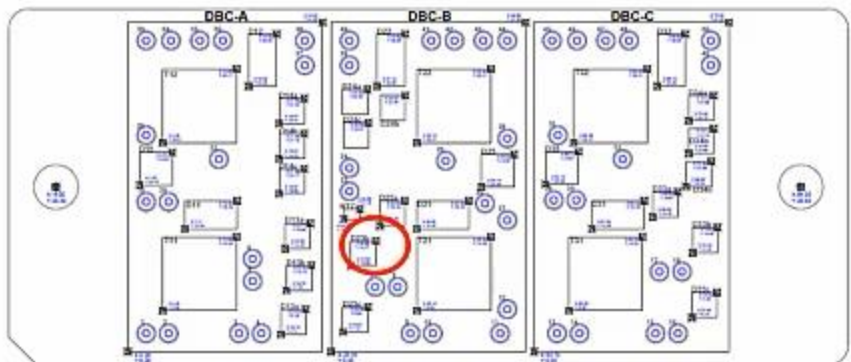
单管优势:

1. 供应厂家多
2. 器件价格便宜
3. 拓扑灵活

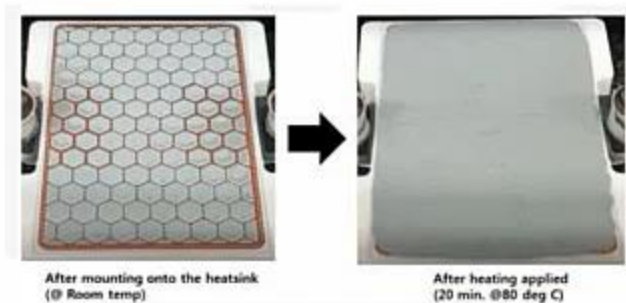
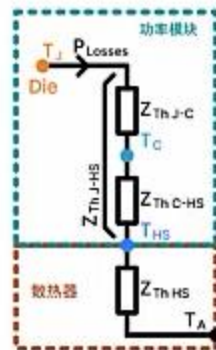


功率模块方案的散热优势

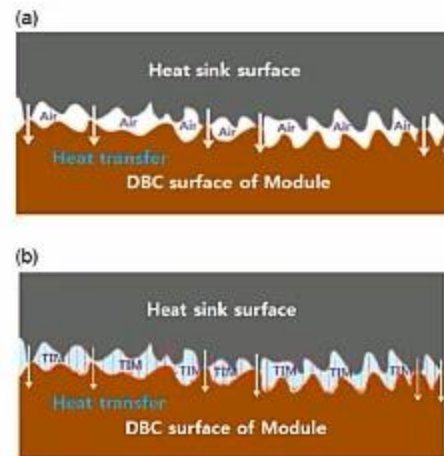
- DBC衬底
 - 电气绝缘
 - 与导热界面的良好的导热连接
- 预涂TIM以提高热导率
 - 精确的密度/厚度控制的蜂窝印刷
 - 全温度下优秀的热导能力
 - 填充散热器和衬底空间
- 依靠内置NTC进行监控
 - 更精确的 T_J



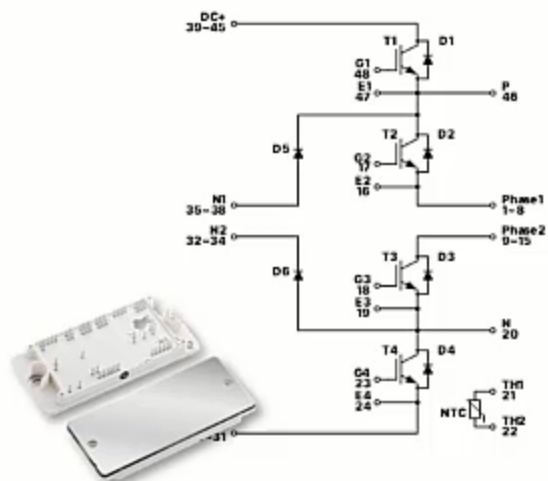
功率模块的热组装和等效模型



预涂PC-TIM的F2模块和导热示意图

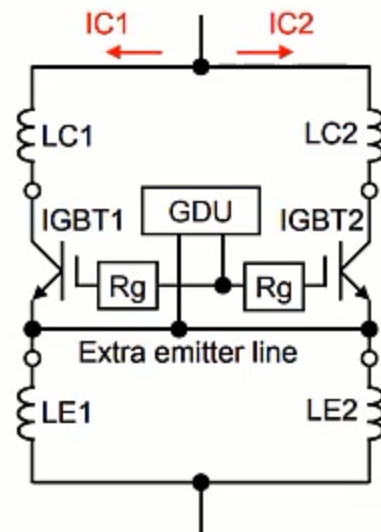
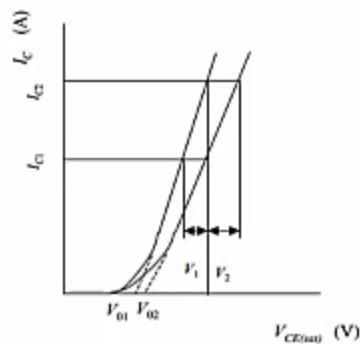
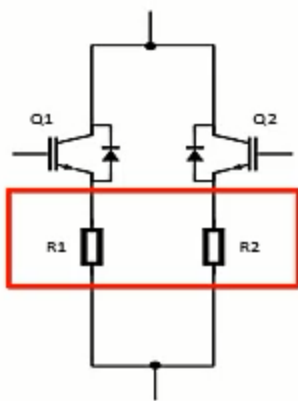


模块内部设计优化 – 均流以及寄生电感

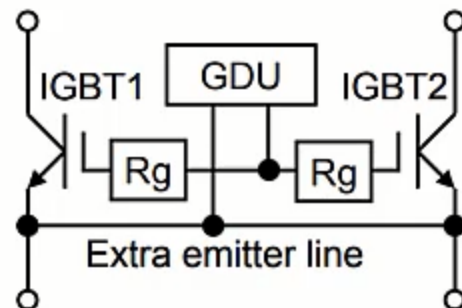


NXH400N100L4Q2F2SG

Description	Target BOM/ parallel x	Qty/Module
T1, T2, T3, T4	1000V, 200A, IGBT, 2x	8
D1, D2, D3, D4, D5, D6	1000V, 75A, HyperFast Diode, 3x	18
NTC	5kohm, 2012, 1% :	1
Pin	Soldering Pin / Press-fit Pin	48



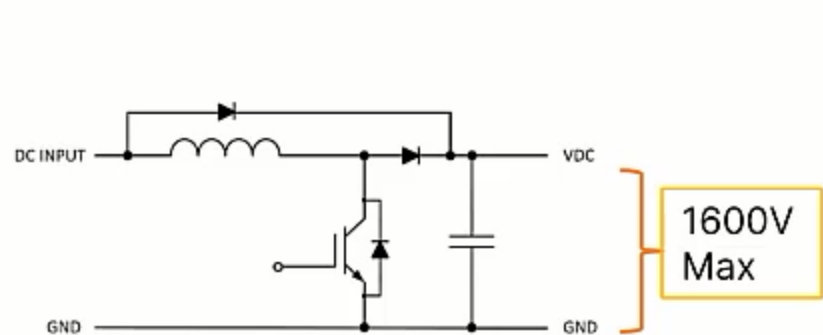
- 控制并减少寄生电感
 - ✓ 对称的走线
 - ✓ 较粗但较短的bond线
 - ✓ 增加bond线数量



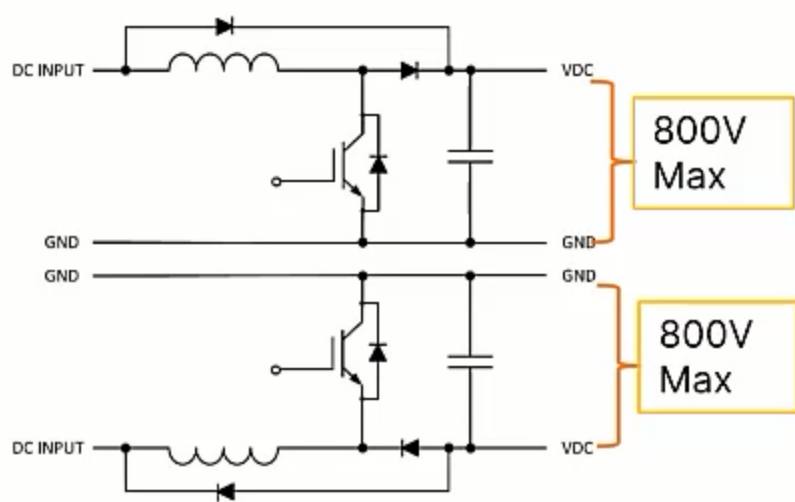
- 单对双的驱动方式
 - ✓ 简单对称的驱动回路
 - ✓ Kelvin source

1500V DCDC boost 拓扑结构

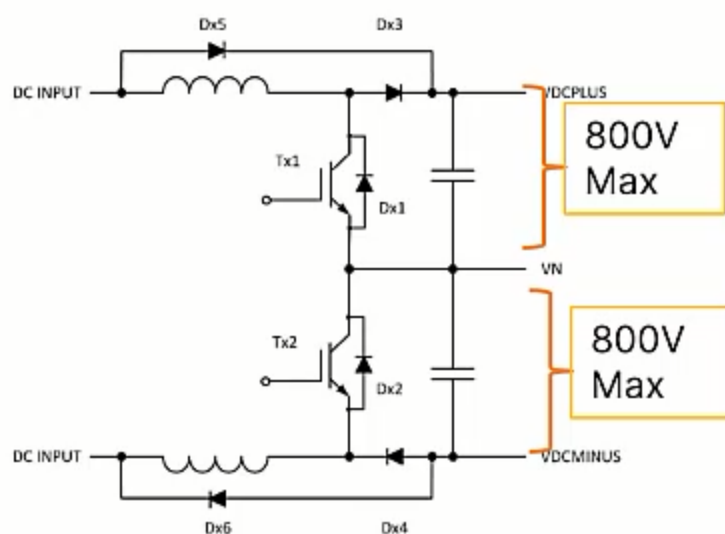
- 两电平Boost (BV电压2000 V)
- 三电平Boost: (BV电压1000 V)
 - 对称三电平
 - 飞跨电容三电平



标准两电平 Boost 拓扑

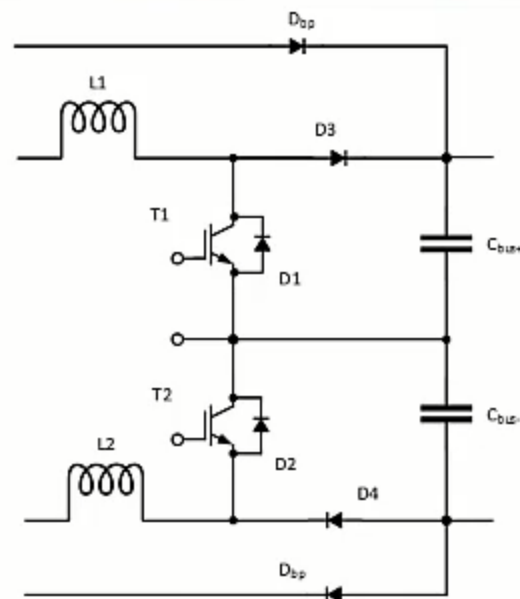


对称三电平boost拓扑

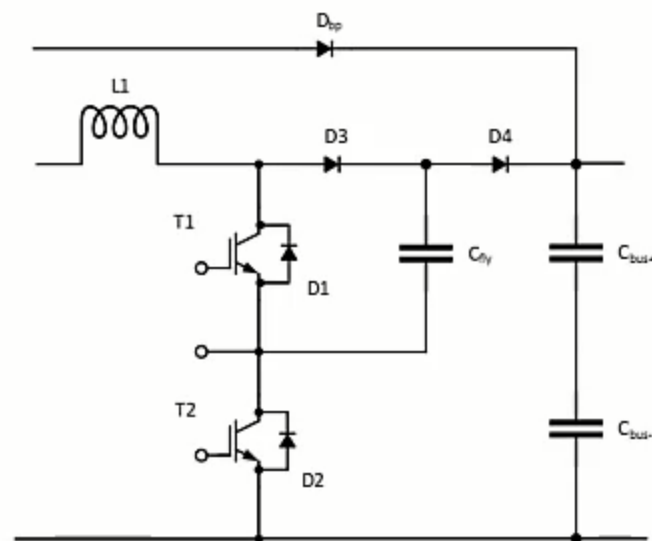


对比三电平Boost拓扑

- 飞跨电容拓扑优势:
 - 允许两个IGBT交错PWM, 可使用较小的电感值
 - 共地, 减小元器件个数
 - EMI 电感
 - PID, Y 电容
 - 连接头和导线
- 飞跨电容拓扑劣势:
 - 额外的飞跨电容及其电压控制
 - 启动电路为飞跨电容充电
 - 控制算法复杂
 - 规避专利



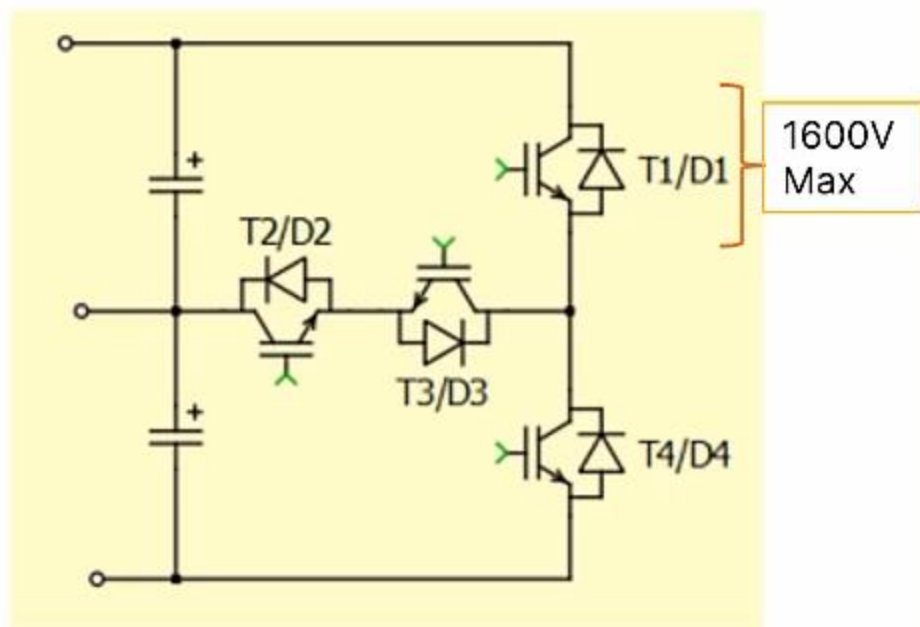
对称三电平拓扑



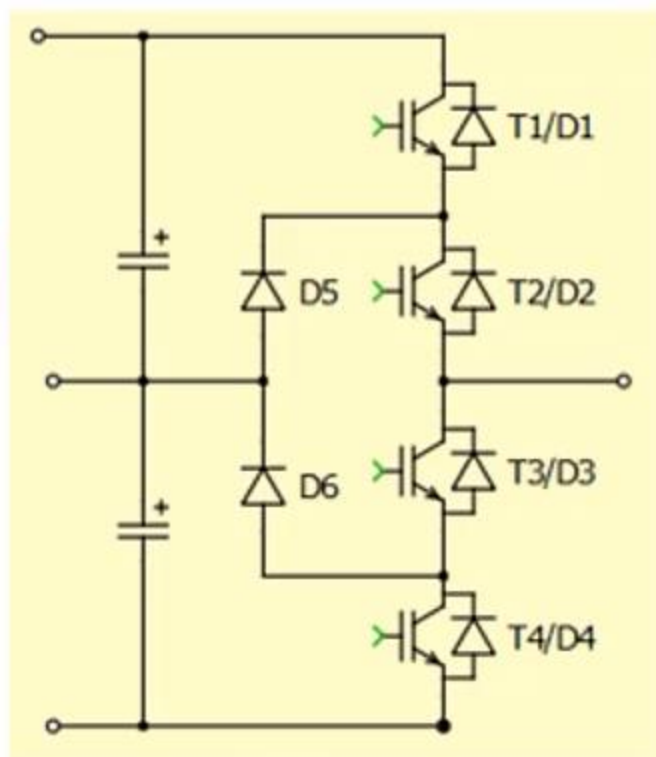
飞跨电容三电平拓扑

1500V DCAC inverter 拓扑结构

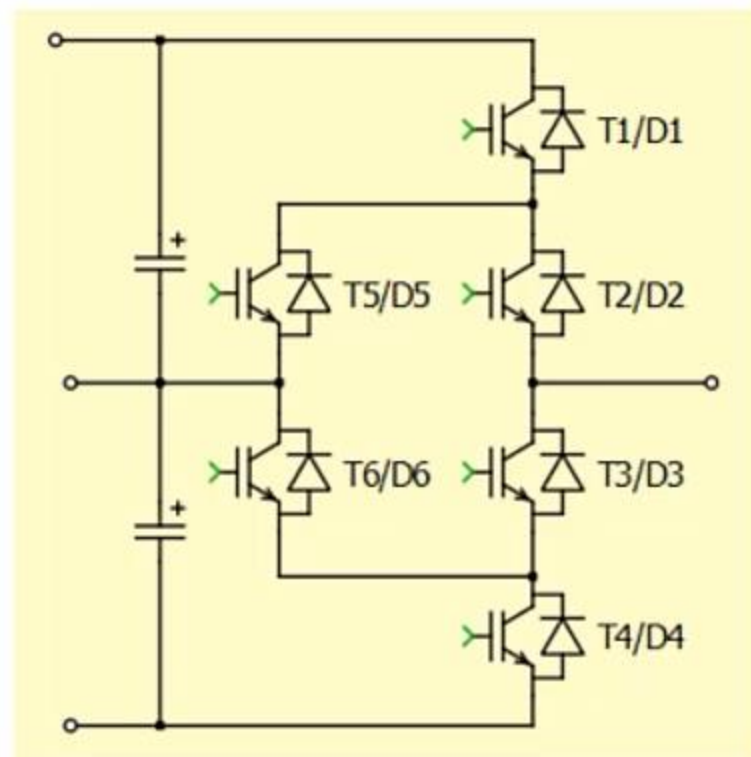
- 主要三电平逆变拓扑： TNPC, INPC, ANPC
- TNCP 外管器件需要支撑全母线电压（最高1600V）
- INPC, ANPC 所有器件只需要支撑半母线电压（800V）， 选用1000V IGBT和二极



TNPC



INPC

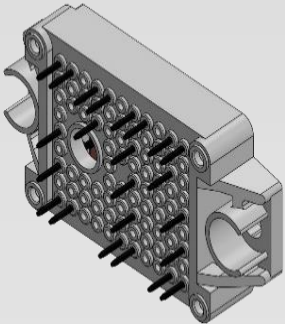


ANPC

Solar Solution

Gel-filled Modules for Energy Infrastructure

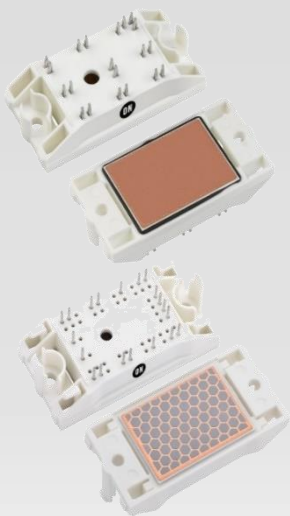
F1



1.2 mm press-fit pins
Solder pins

With TIM/no TIM

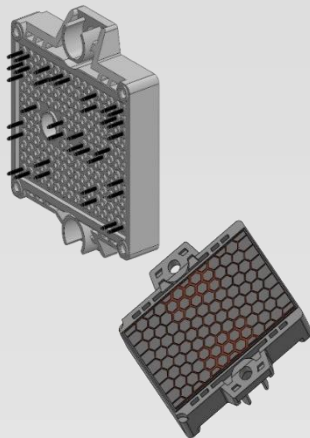
Q0



1.2 mm press-fit pins
1.6 mm press-fit pins
Solder pins

With TIM/no TIM

F2



1.2 mm press-fit pins
Solder pins

With TIM/no TIM

Q1



1.2 mm press-fit pins
1.6mm press-fit pins
Solder pins

With TIM/no TIM

Q2

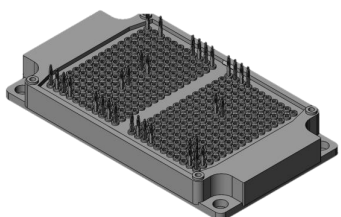


with base plate

1.6 mm press-fit pins
Solder pins

With TIM/no TIM

F5+BP



with base plate

1.2 mm press-fit pins
Solder pins

With TIM/no TIM

onsemi PIM Package

Q0



达25 kW(升压模块)
达15 kW(逆变模块)

Q1



达40kW (升压模块)
达20kW (逆变模块)

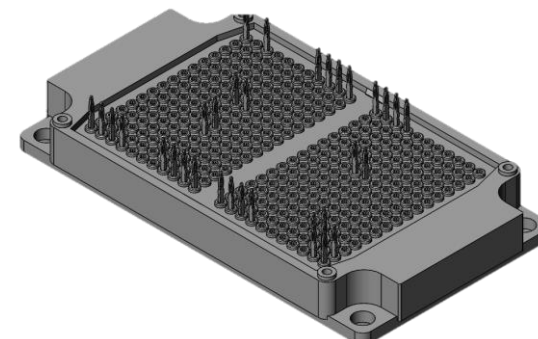
Q2



带铜基板（增强散热）

达75 kW（1500V 逆变模块）
达45 kW（1100V 逆变模块）

F5+BP

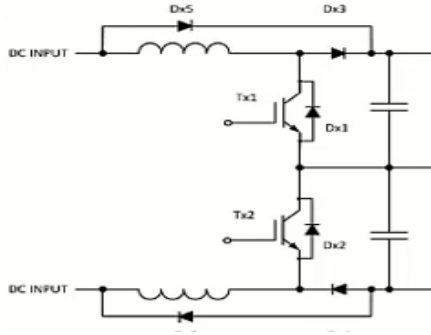


带铜基板（增强散热）

达100 kW
(1500V 逆变模块)

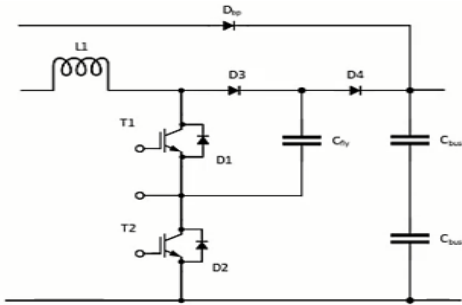
onsemi

Q2 Symmetric Boost for 1500V System



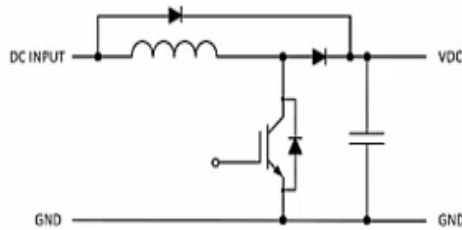
Symmetric Boost (IGBT+SiC Diodes)

NXH450B100H4Q2F2SG	150-250KW	8-12 Channel	<35A PV
NXH600B100H4Q2F2SG	300-350KW	12 Channel	<45A PV



Flying cap Boost (IGBT+SiC Diodes)

NXH300B100H4Q2F2SG	150-250KW	8-12 Channel	<35A PV
NXH600B100H4Q2F2S1G	300-350KW	12 Channel	<45A PV
NXH400B100H4Q2	300KW+	6 Channel	65A PV



4CH 2L 2kV full SiC Boost (SiC Mosfet+SiC Diodes)

20mohm SiC Mosfet, 50A SiC diode	320KW	12 Channel	40A PV
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Inverter PIMs - 1500V / 200-350kW

Features

- Family for 1500V Decentralized Utility Inverters
 - 1000V 350A & 400A I-type NPC
 - 1000V 800A A-type Split NPC
- SiC Diodes for higher efficiency and power density
- Thermistor

Benefits

- Maximizes power density
- Light and compact systems
- Simplifies infrastructure deployment on field

Specifications

Product	Description	
NXH350N100H4Q2	1 Channel 350A 1000V I-type NPC	225KW Q2
NXH400N100H4Q2	1 Channel 400A 1000V I-type NPC	250KW Q2
NXH600N100L4F5	1 Channel 600A 1000V I-type NPC	300KW F5+BP
NXH800A100L4Q2	1 Channel 800A 1000V A-type split NPC	320KW Q2

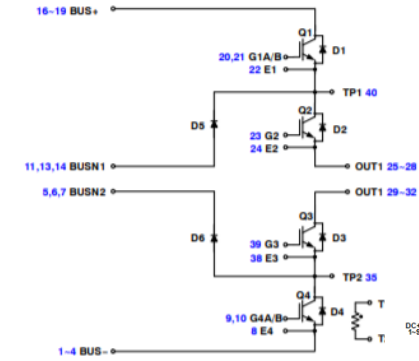
Package



End products

- Solar Inverter
- UPS
- Energy Storage

Block Diagrams: Solution for 1500V Solar Inverter



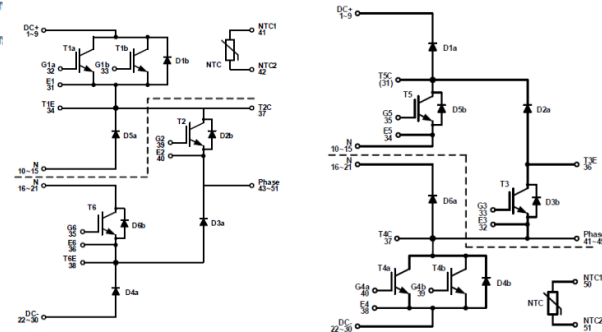
NXH350N100H4Q2

NXH400N100H4Q2

NXH600N100L4F5

NXH800A100L4Q2F2S1G

NXH800A100L4Q2F2S2G



Applications

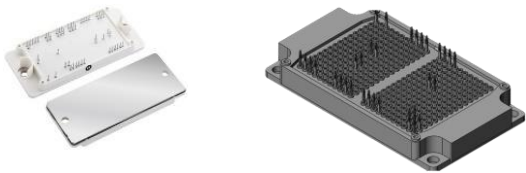
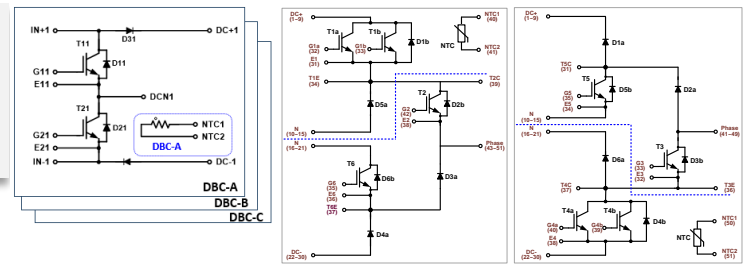
- Industrial Applications

PIM solutions for 1500V multi-string Solar Inverter



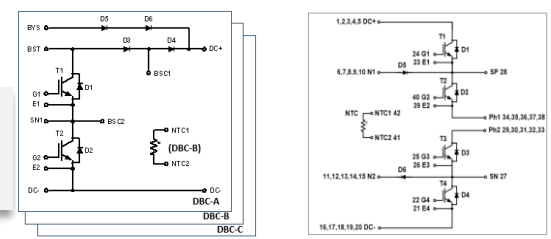
Mass Market
1500V Gen III
Solar PIMs

- NXH600B100H4Q2F2SG
 - NXH800A100L4Q2F2S1G
 - NXH800A100L4Q2F2S2G
- ~350kW**



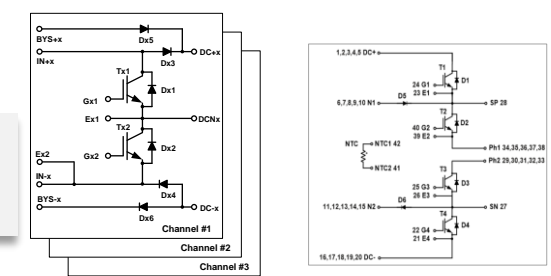
Mass Market
1500V Gen II
Solar PIMs

- NXH300B100H4Q2F2SG/-PG
 - NXH400N100H4Q2F2SG/-PG
- ~250kW**



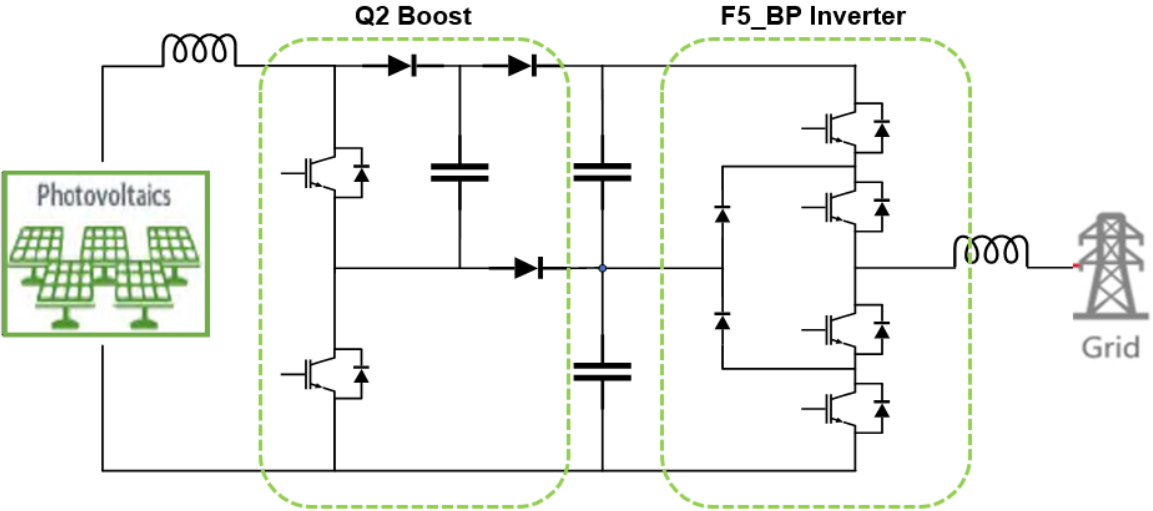
Mass Market
1500V Gen I
Solar PIMs

- NXH450B100H4Q2F2SG/-PG
 - NXH350N100H4Q2F2S1G/-P1G
- 175~225kW**



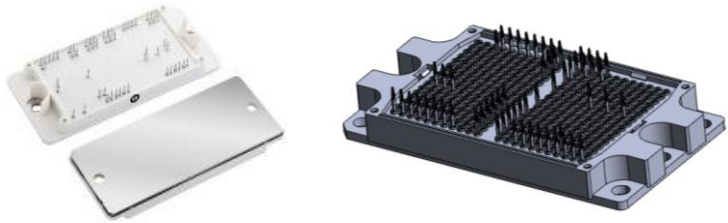
PV Cell Size	Current per String	Current per Channel w/ 2 String
156mm x 156mm	13A	26A
180mm x 180mm	15A	30A
210mm x 210mm	20 - 22A	40 - 44A

F5+BP-PIM solution for 1500V & 1100V Solar Inverter

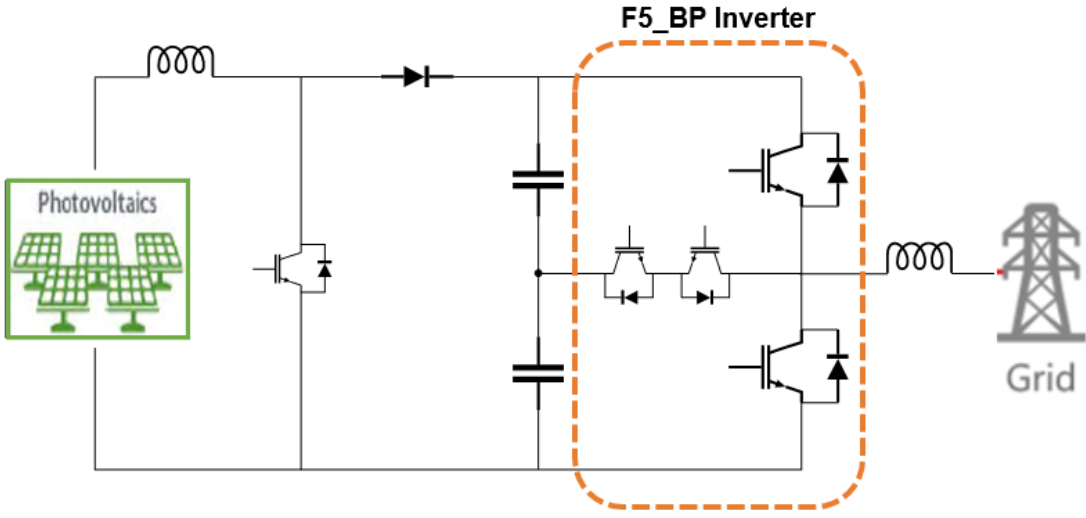


3NXH400B100H4F5PG*3

NXH600N100L4F5PG*3

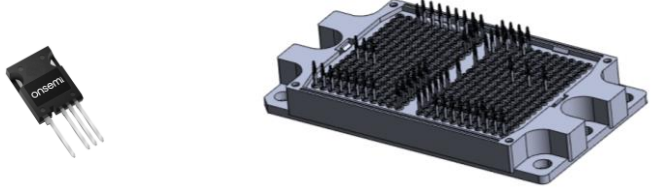


F5+BP Solar Inverter for 1500V 300KW
NXH600N100L4F5PG/ 600A INPC



FGY4L160T120SWD*6

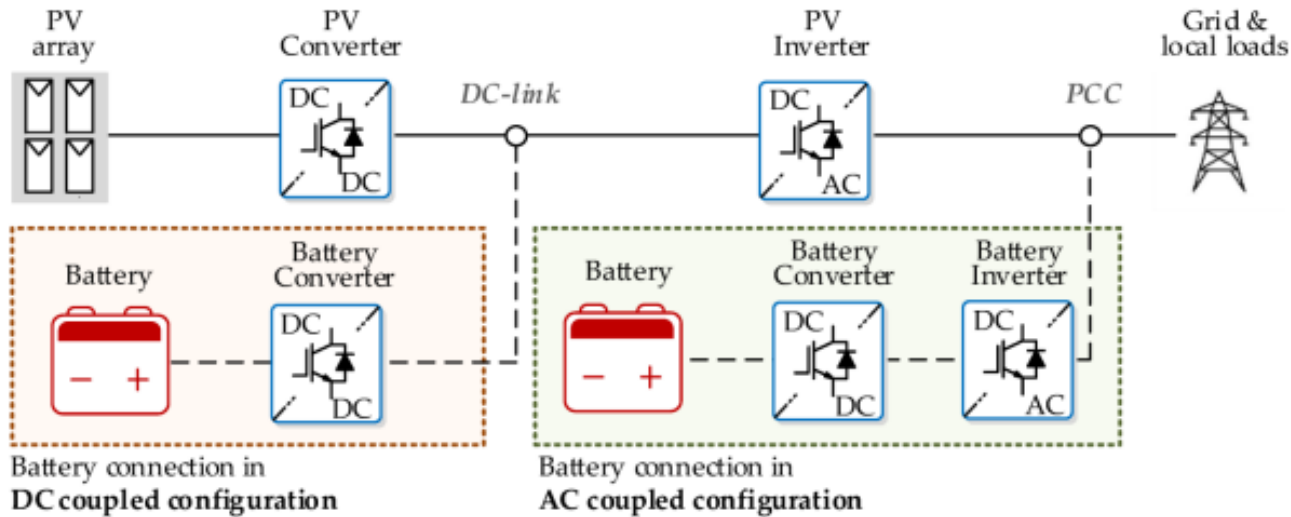
NXH600T120L7F5PG*3



F5+BP Solar Inverter for 1100V 150KW
NXH600T120L7F5PG / 600A TNPC

ESS Solution

典型储能框图



两种分类方式

功率等级

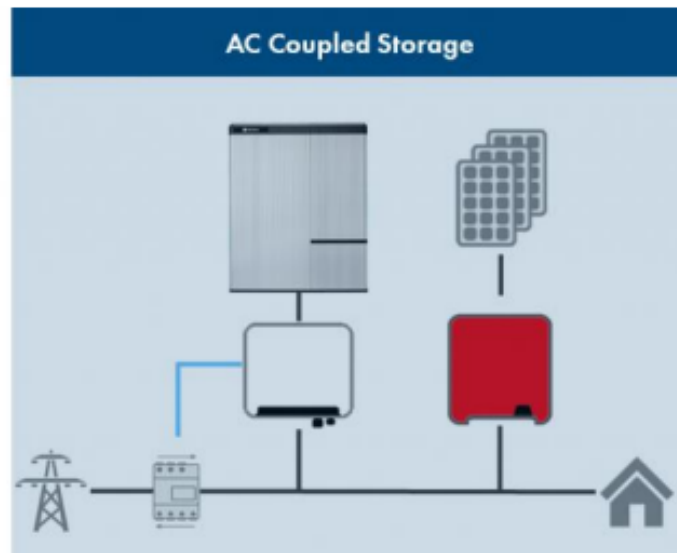
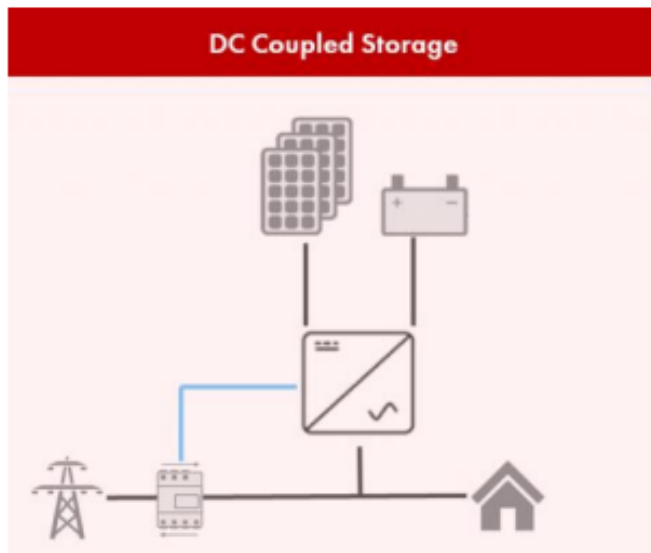
耦合方式

功率级

单相最高可达4kW-7kW(甚至15kW) “住宅”
三相100kW-2MW (单台15kW-150kW) “商用”
三相5MW及以上(单台150kW-300kW)
“地面电站”

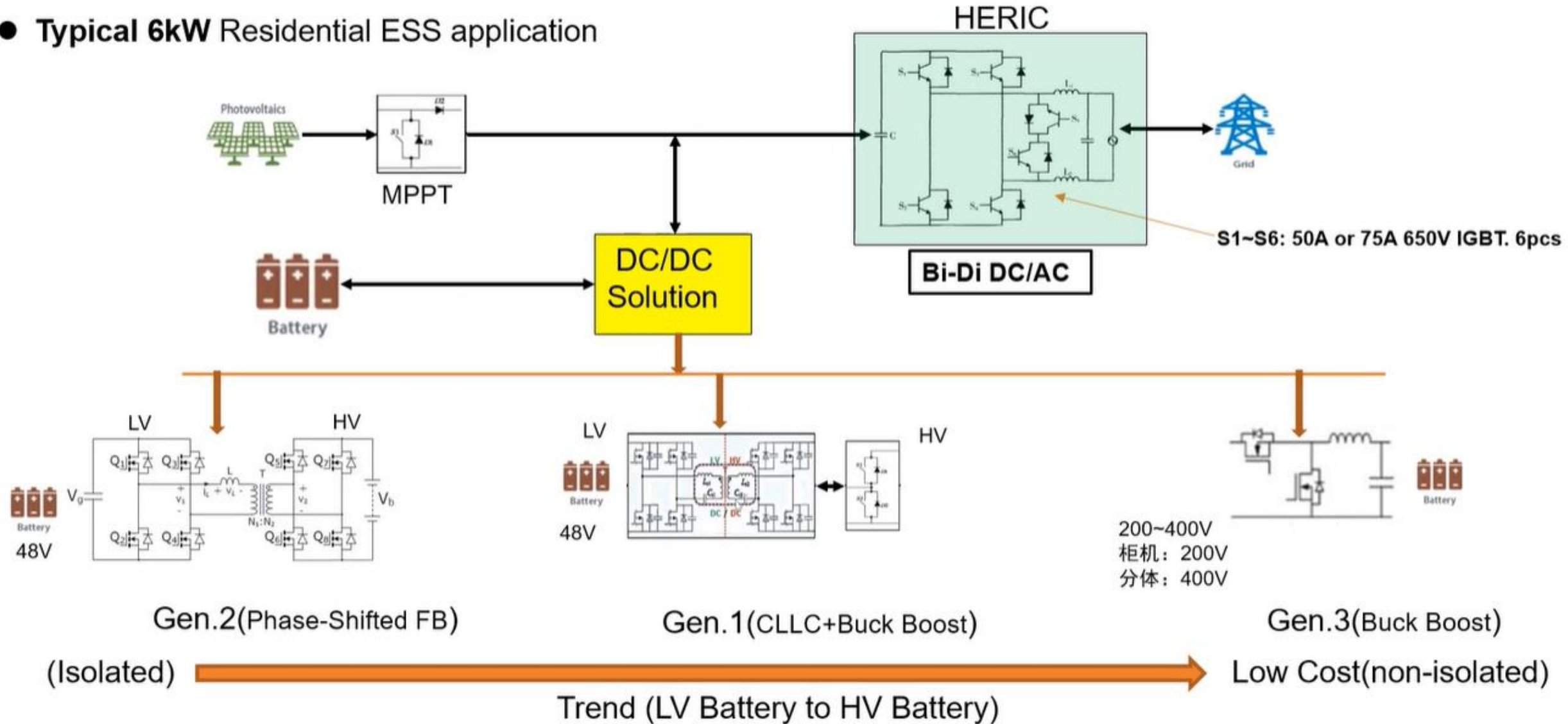
耦合

直流耦合效率更高,但不能随意加装
交流耦合效率较低,但可以添加到现有系统中



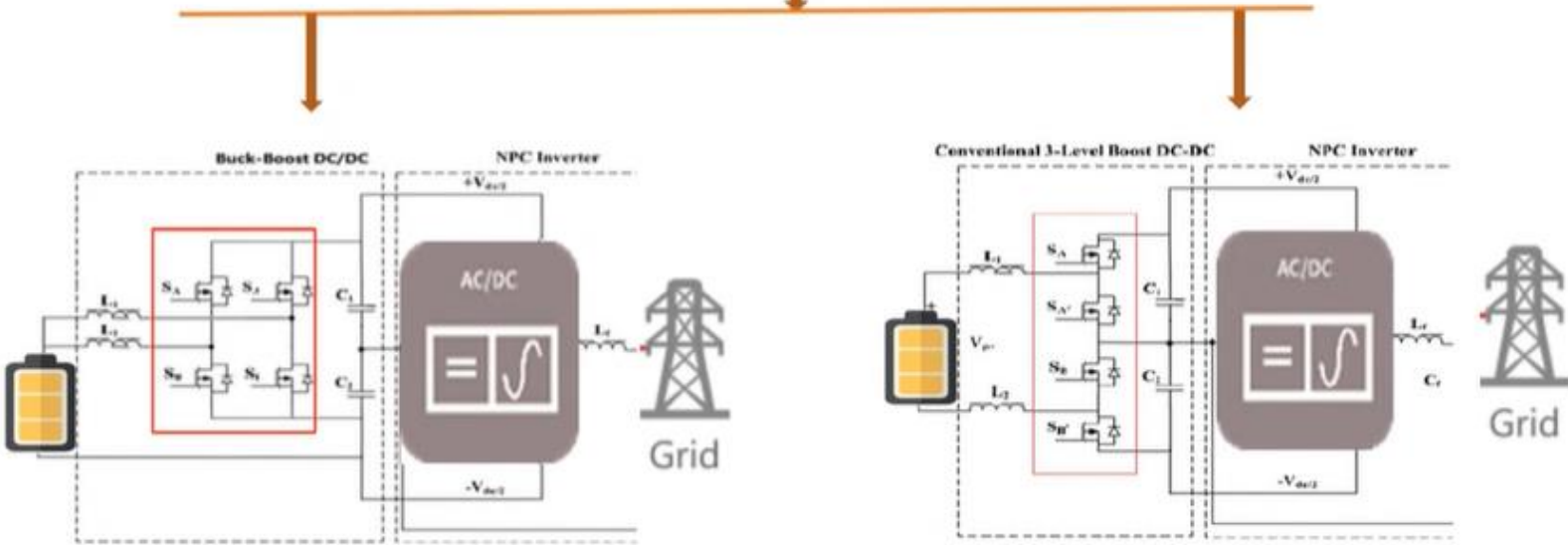
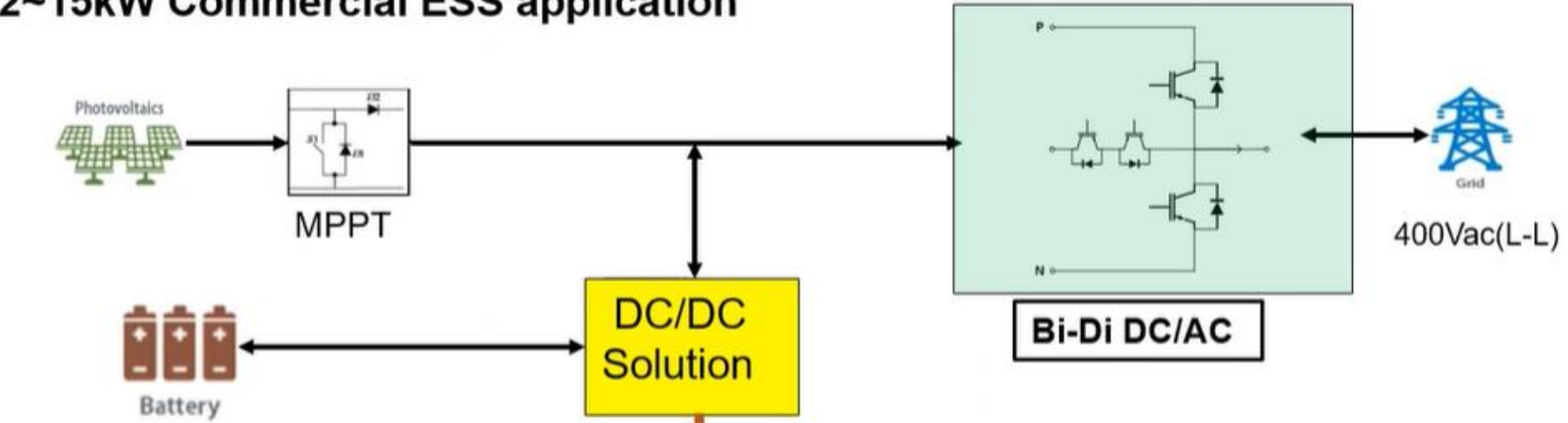
PCS (Power conversion system) Topology and System (HERIC)

- Typical 6kW Residential ESS application



PCSTopology and System(DC Couple Commercial)

- Typical 12~15kW Commercial ESS application



In China, mainly for 380V 3p AC output with Battery voltage- 600~800V system.

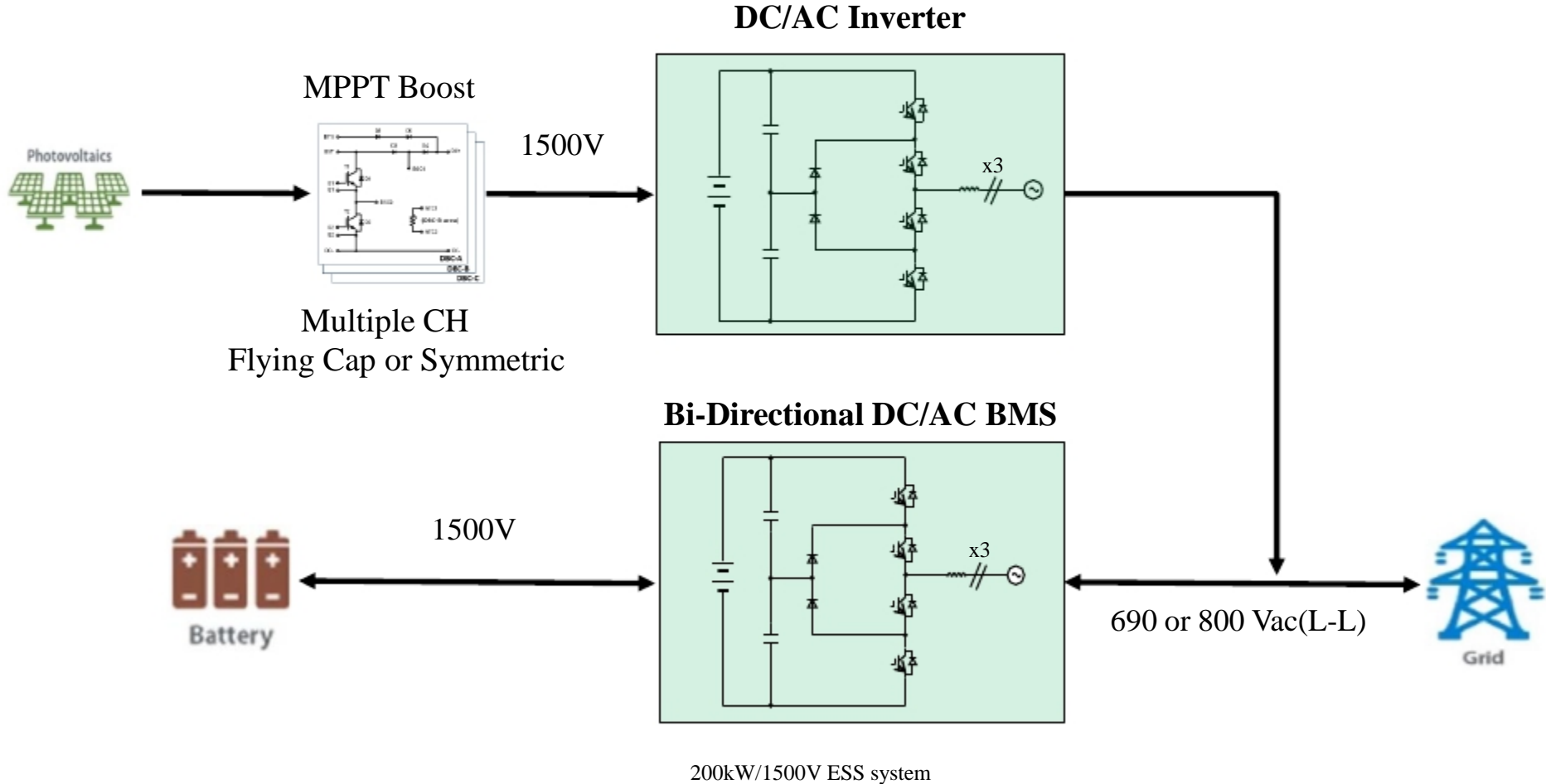
Oversea partially used 3p 480Vac Battery voltage- 800~1100V system.

Buck-Boost

Dual Buck-Boost

PCS(Power conversion system) Topology and System(AC Couple Commercial)

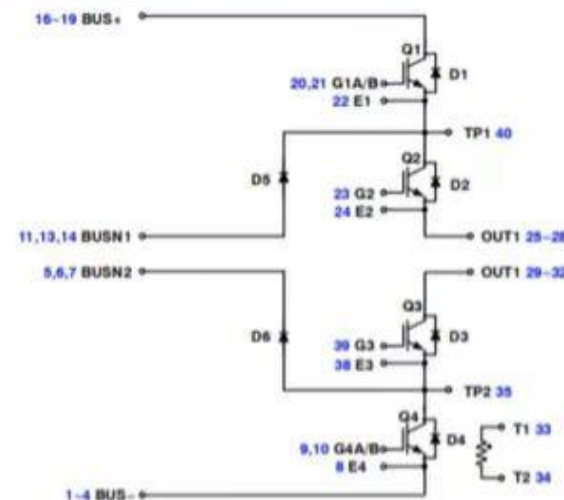
● Typical 200kW Commercial ESS application



Q2 PIM ESS solution



Block Diagrams: Solution for 1500V ESS Inverter



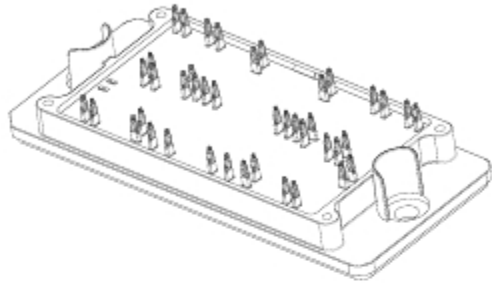
ESS (AC Coupled)

PNs (M/P)	amount	Power	Bus Voltage/ AC output
NXH350N100H4Q2F2S1G	6pcs (Parallel)	200KW-240KW	1000-1500Vdc / 690Vac(L-L)
NXH400N100H4Q2F2SG	3pcs	160KW	1000-1500Vdc / 690Vac(L-L)
NXH400N100H4Q2F2SG	6pcs (Parallel)	240KW-300KW	1000-1500Vdc / 690Vac(L-L)
NXH400N100L4Q2F2SG	3pcs	180KW-200KW	1000-1500Vdc / 690Vac(L-L)
NXH400N100L4Q2F2SG	6pcs (Parallel)	300KW-350KW	1000-1500Vdc / 690Vac(L-L)
NXH600N65L4Q2F2SG	3pcs	100KW	600V-1000Vdc/ 400Vac(L-L)
600A INPC NPD	3pcs	200KW-220KW	1000-1500Vdc / 690Vac(L-L)

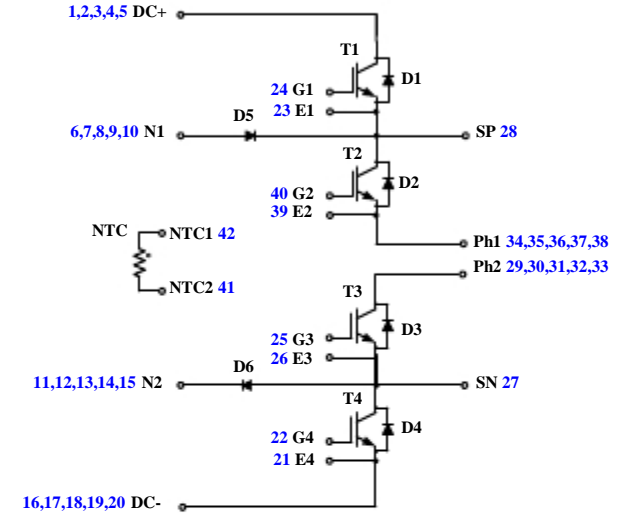
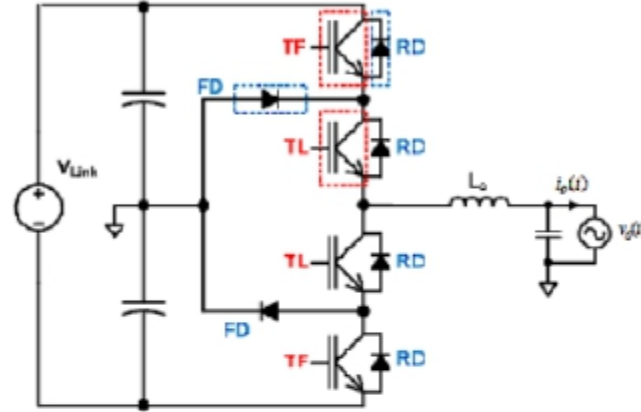
180-200kW 1500V ESS Solution

NXH400N100L4 NPI*3pcs, updated RD to 225A+, FD to 225A+.

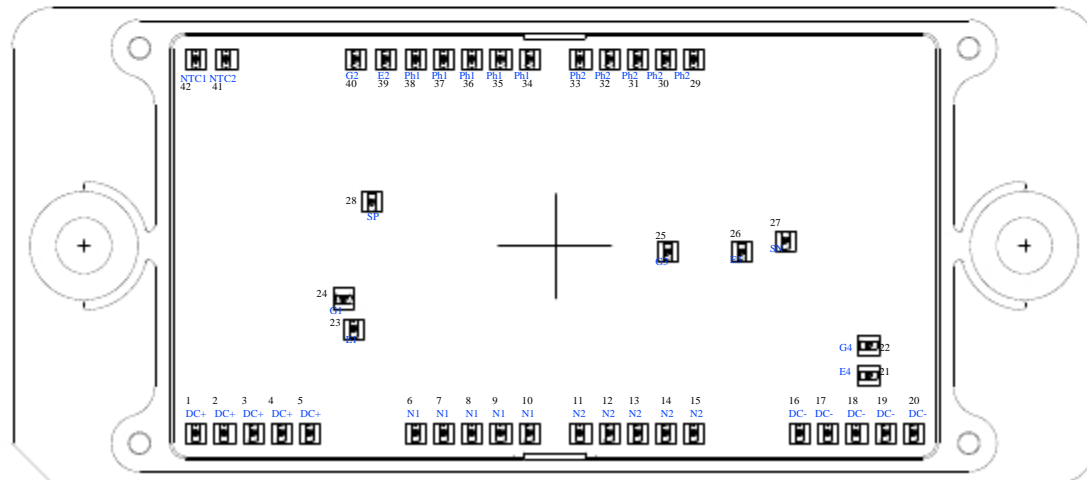
◆TargetPKG : Q2, Press-fit Pin



Dimension : 107.2 * 47mm
 Representative Package image
 To be updated

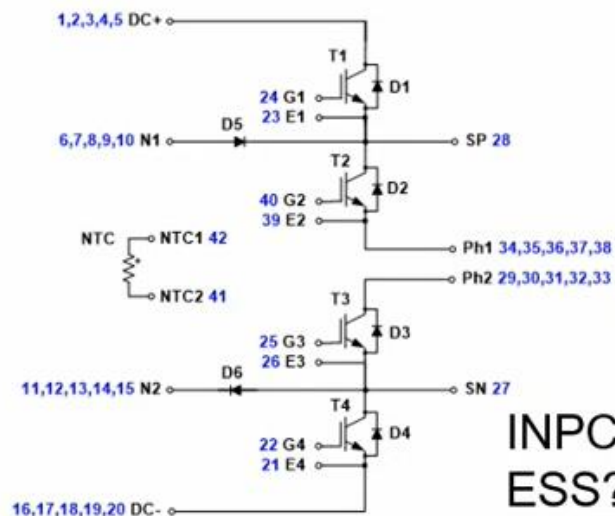


◆TargetPin Assignment



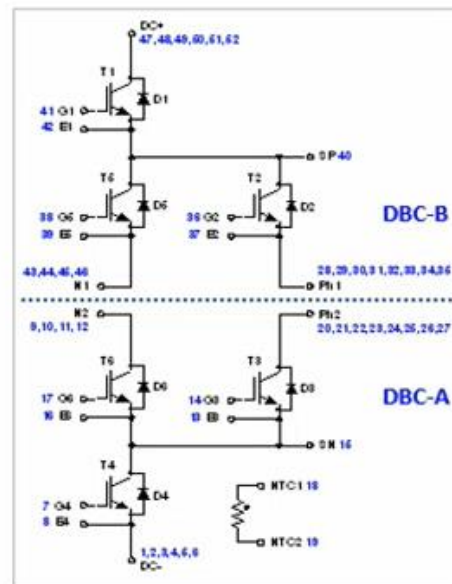
200~220kW 1500V ESS Solution-NPI

◆ Topology proposal

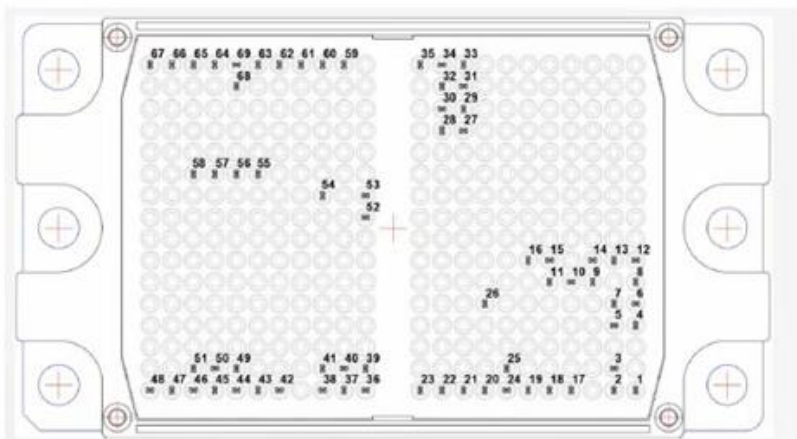


INPC or ANPC for 200kW+ ESS?

F5+BP package power rating up to 250kW+



◆ Package selection



200-220kW ESS modules

600A NPD

INPC

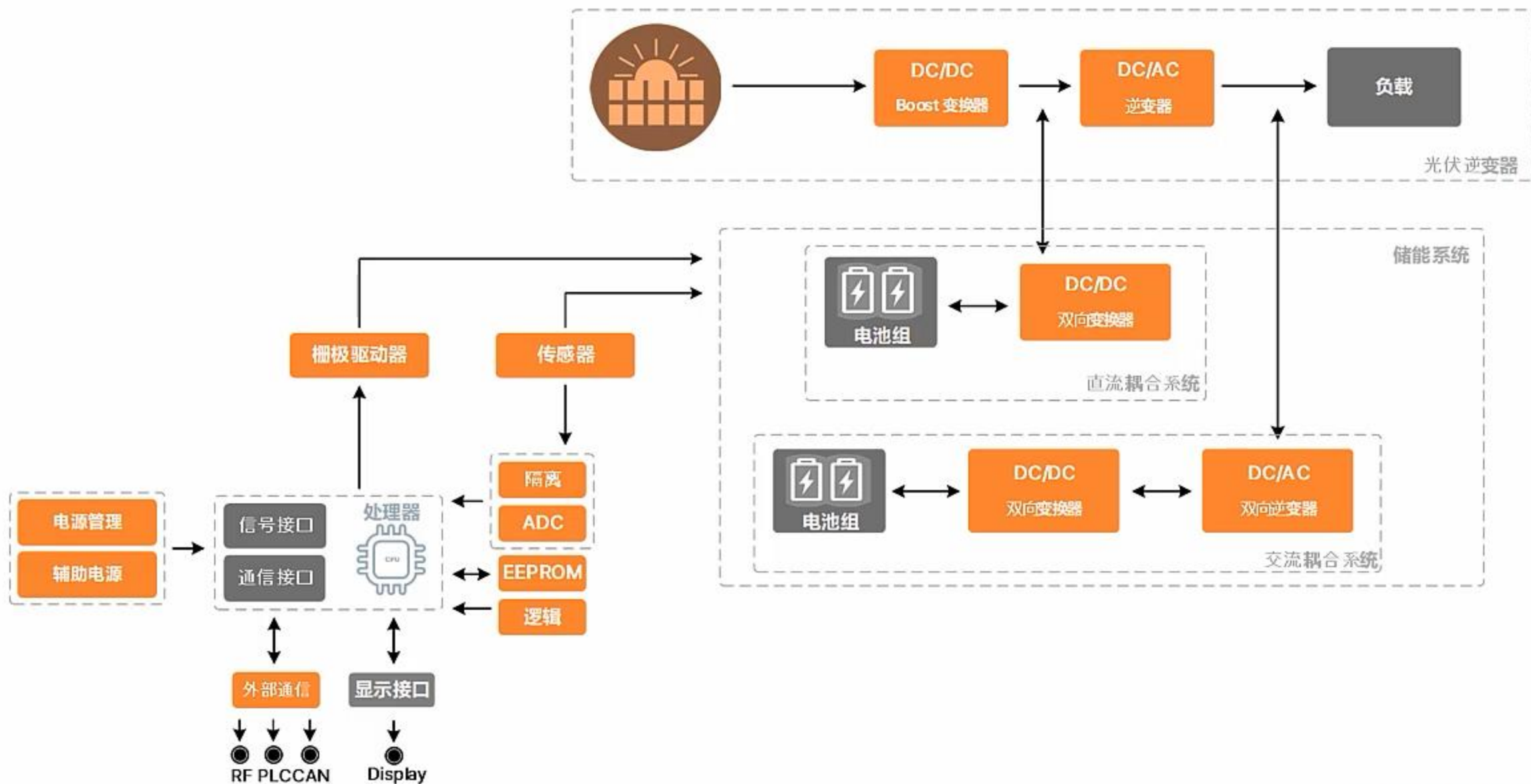
200kW PCS

NPI 220kW ESS modules 1200V IGBT

INPC or ANPC

220kW+ PCS

来自安森美 – 完整的光储充解决方案



Thank you

