英飞凌针对电池供电中低压大电流驱动方案

PMM Roadshow China
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电池供电中低压大电流驱动应用和英飞凌产品

电池供电应用 - 电机驱动功率等级

低功率

家用和专业


电动工具，园艺工具，商用多功能机，无绳家用电器，无绳吸尘器，医疗保健设备

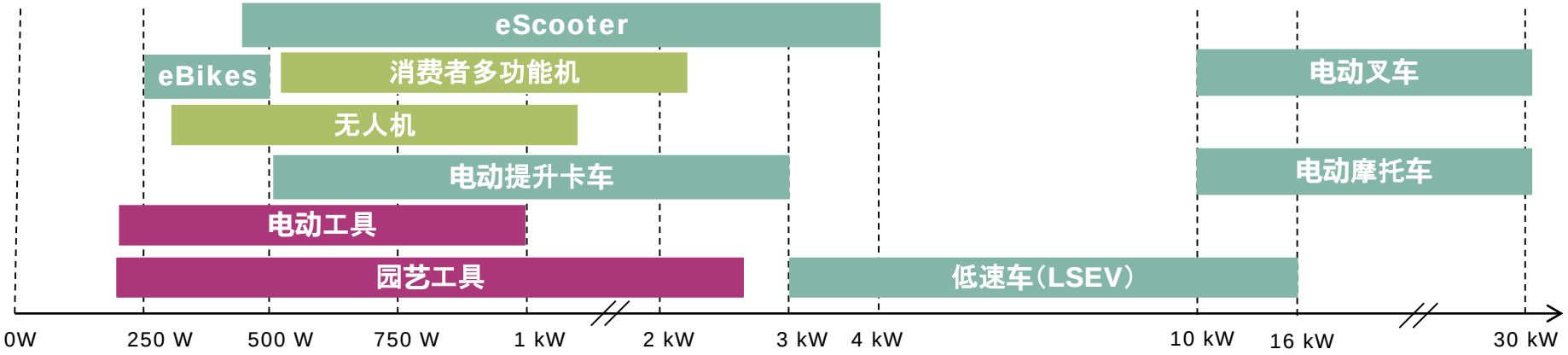
消费类机器人


无人机，消费者多功能机，吸尘机器人，遥控玩具，服务机器人，家用机器人和其他消费机器人

高功率

轻型 / 低速电动车


eScooter，eBike，电动轮椅，电动叉车，低速车（LSEV），电动摩托车，其他电动车



英飞凌在中低压大电流驱动方面的机会

车外 / 车载充电器

功能性	英飞凌电子器件
›电池充电	› CoolMOS™ P7/P7S › OptiMOS™/StrongIRFET™ › AC/DC PFC, PWM ICs, gate driver ICs

电池管理

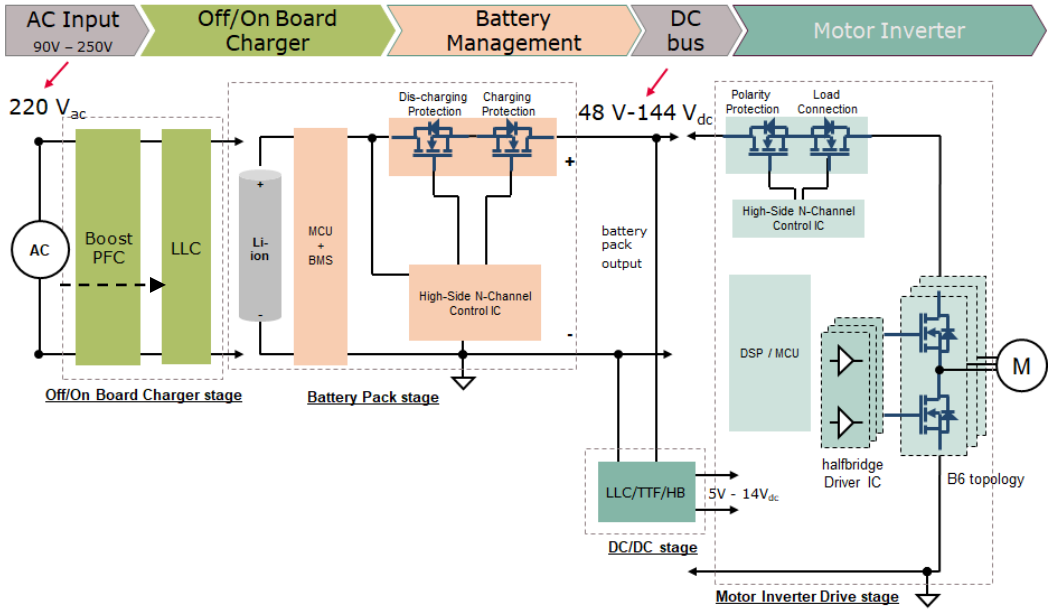
功能性	英飞凌电子器件
›在异常情况下保护电池	› StongIRFET™/OptiMOS™ LinearFET › Small signal MOSFET › XMC™ MCU › OPTIGA™ Trust B

DC / DC电源管理

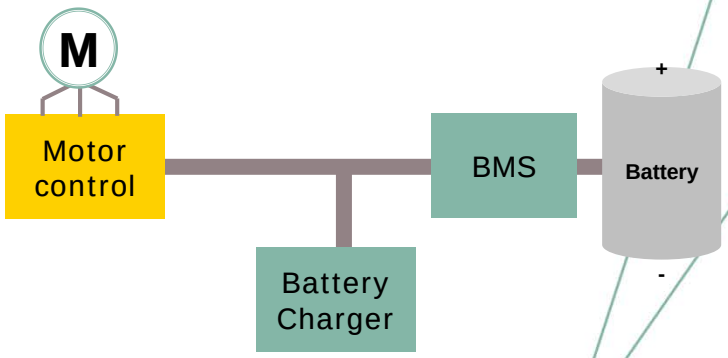
功能性	英飞凌电子器件
›提供适合系统设备的电压/电流的电源	› StrongIRFET™/OptiMOS™ › Gate driver ICs › XMC™ MCU

电机控制

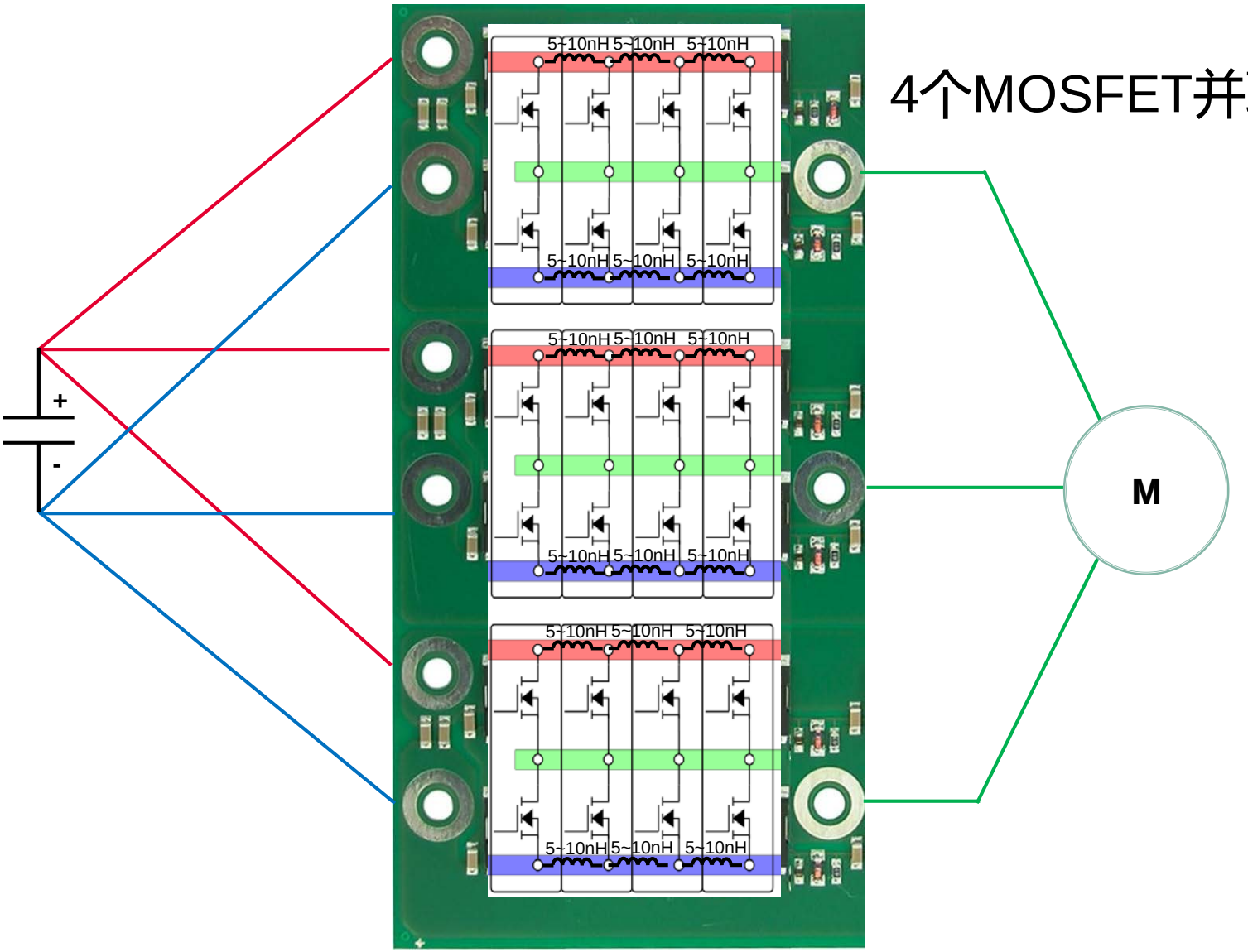
功能性	英飞凌电子器件
›具有正确电压/电流的电源，用于电机驱动以控制电机	› StrongIRFET™/OptiMOS™ › Gate driver ICs › XMC™ MCU › Hall sensor



电驱应用挑战性和有关方案

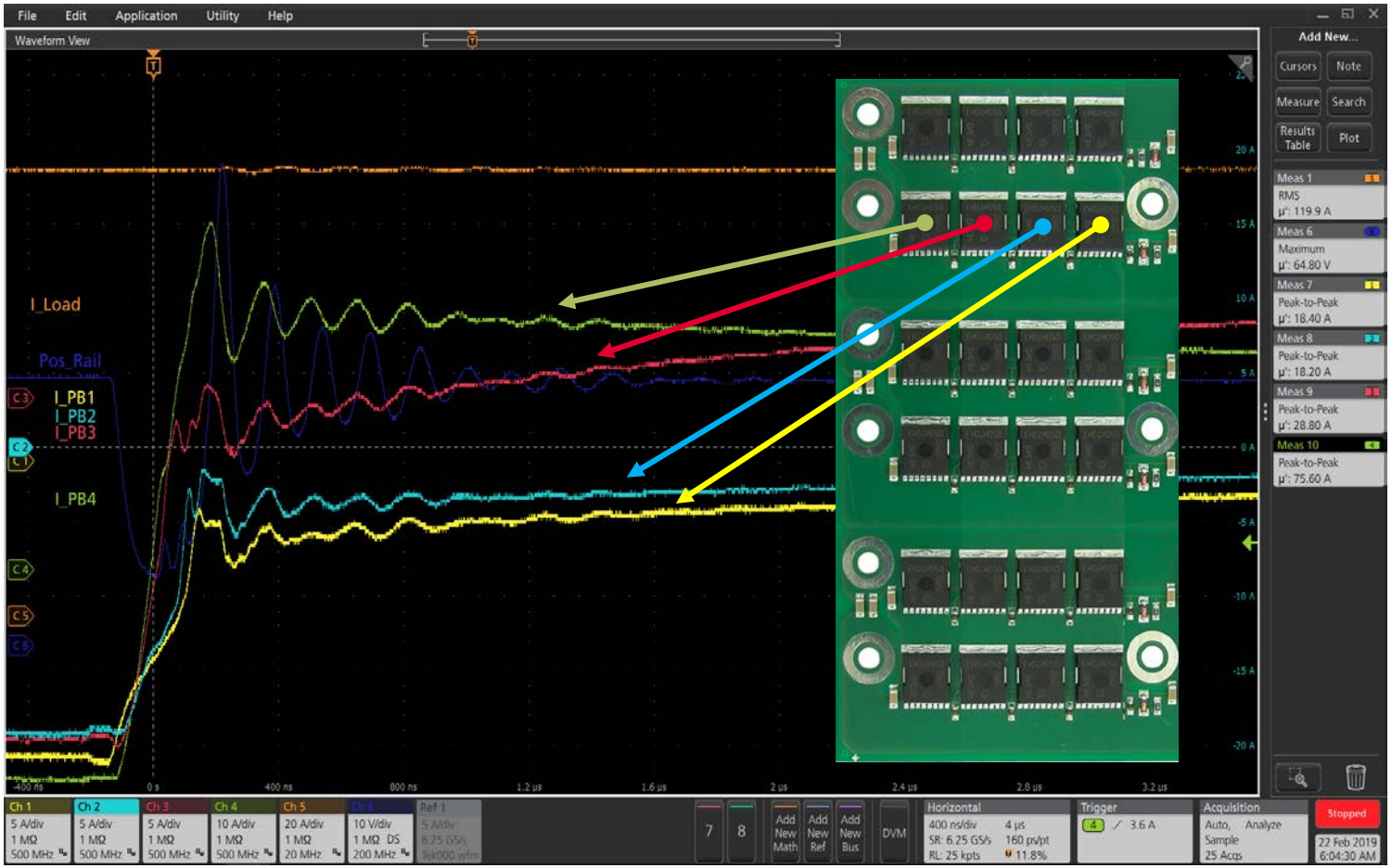


三相变频电机驱动系统



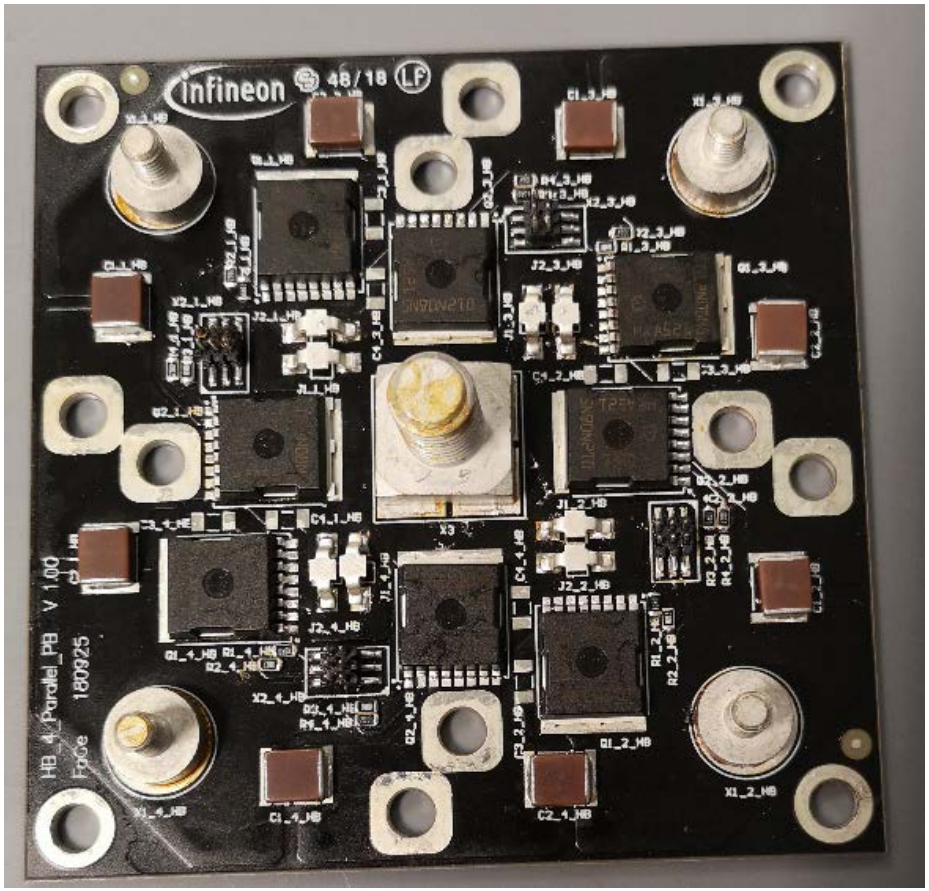
4个MOSFET并联

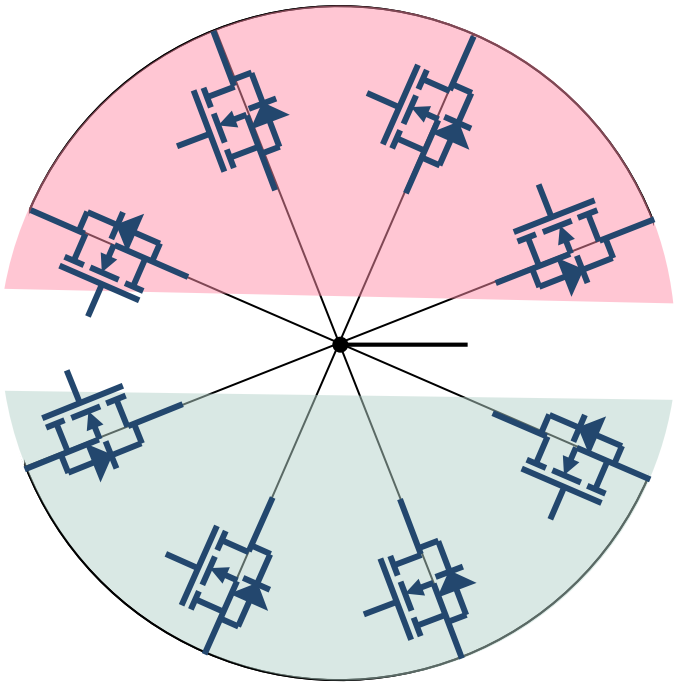
实验测试



› **实验测试证实了当前MOSEFTs的不匹配**

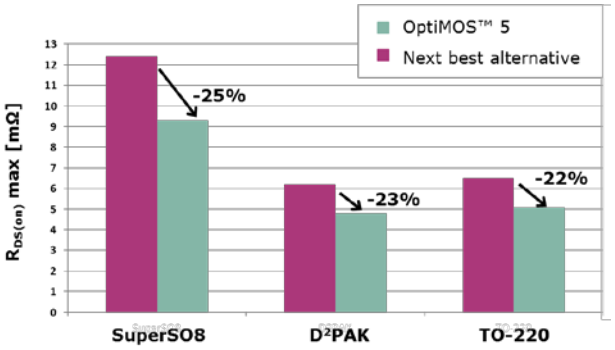
对称PCB布局



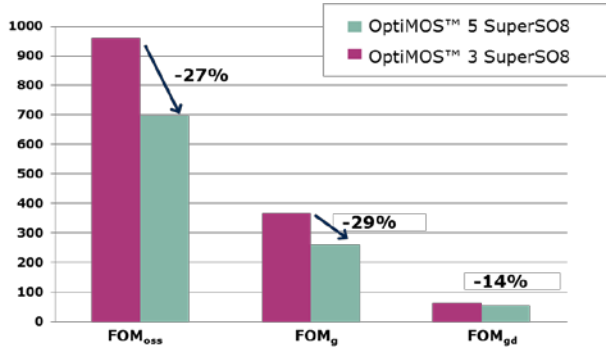


受PCB面积限制

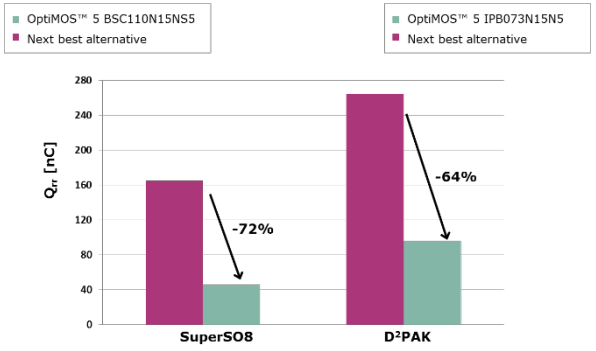
OptiMOS™ 5 (80V-150V)
突出的功能和优点



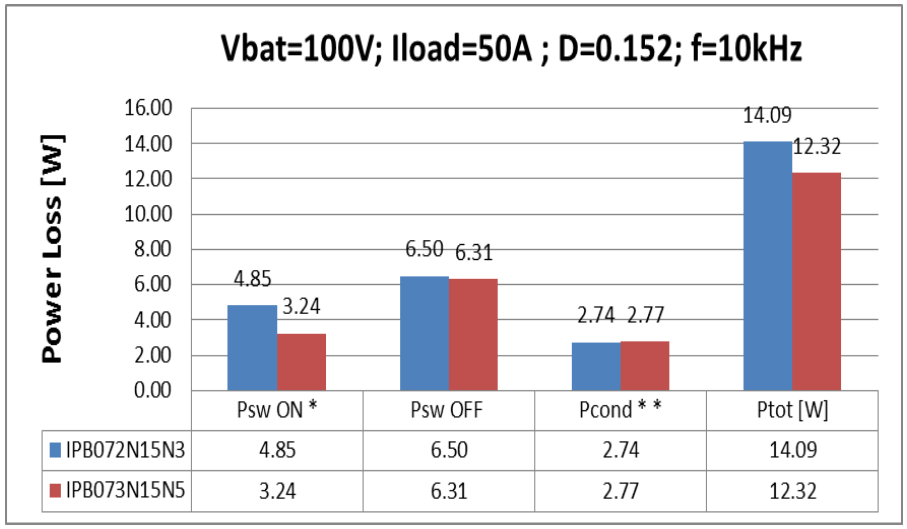
Breakthrough reduction in $R_{DS(on)}$ without compromising FOM_{gd} and FOM_{oss}



Improved FOMs



Ultra-low reverse recovery charge



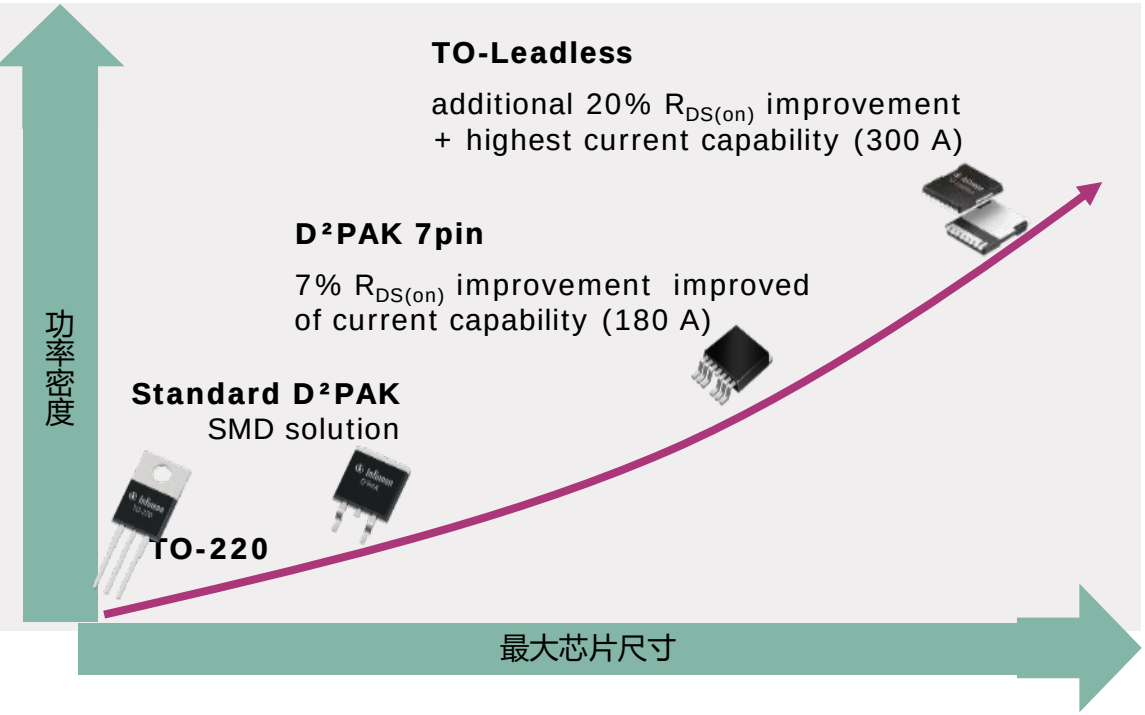
Vbat=100V; Iload=50A ; D=0.152; f=10kHz		
LOSS	IPB072N15N3	IPB073N15N5
Ptot [W]	14.09	12.32
Tswich,max HS [°C]	126.00	100.00

***includes reverse recovery loss (Qrr) and also Qoss loss**

*** *due to Rds,on variation between parts, only Rds,on,max @25C data sheet value was used**

功率封装演进路径：从标准TO解决方案到无引线器件的电机控制

高功率封装之路 – TO-Leadless

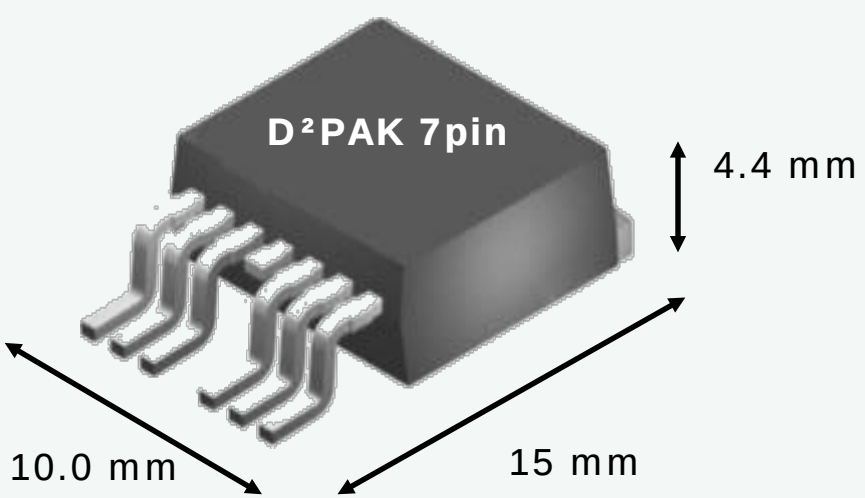


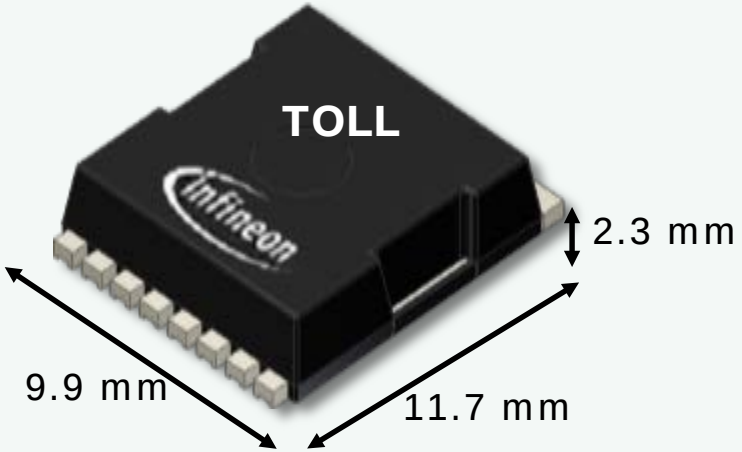
使用更高电流密度的封装：

- 提高系统功率密度
- 减少并联的MOSFET数量

OptiMOS™ in TO-Leadless		
Voltage class	**Product type**	**$R_{DS(on)}$ max. @V_{GS} = 10 V [mΩ]**
250V	IPT210N25NFD	21 mΩ
200V	IPT111N20NFD	11.1mΩ
150V	IPT059N15N3	2.9mΩ
100V	IPT020N10N5	2 mΩ
	IPT026N10N5	2.6 mΩ
	IPT015N10N5	1.5 mΩ
	IPT020N10N3	2 mΩ
80V	IPT019N08N5	1.9 mΩ
	IPT012N08N5	1.2 mΩ
	IPT029N08N5	2.9 mΩ
60V	IPT007N06N	0.75 mΩ
	IPT012N06N	1.2 mΩ
40V	IRL40T209	0.72 mΩ
30V	IPT004N03L	0.4 mΩ

TO-Leadless (TOLL) package - a replacement for D²PAK 7pin by 60% space reduction





Footprint: 150 mm²

Footprint: 115 mm²

30 % footprint reduction

50 % height reduction

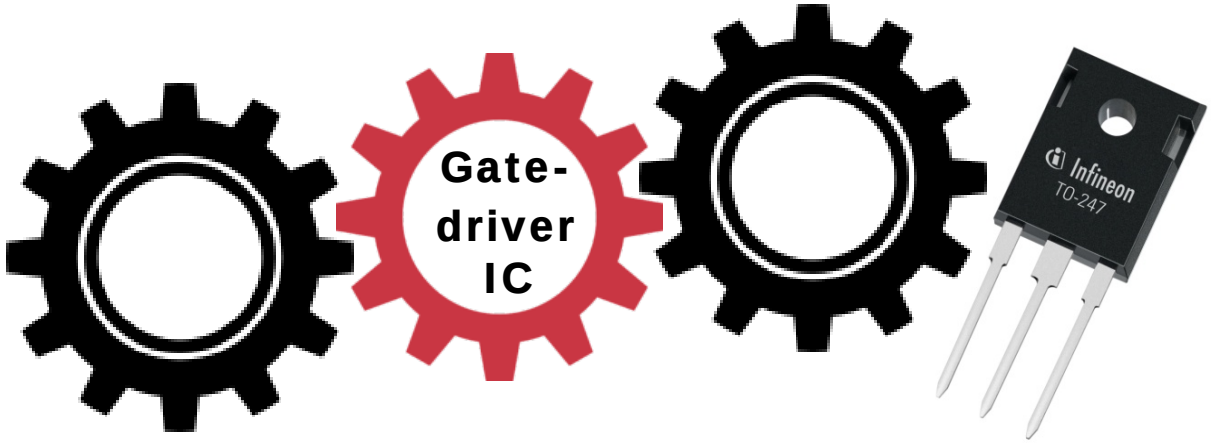
60 % space reduction

哪里使用MOSFET栅极驱动器IC?

3指规则：

- **任何带有数字控制器的Power-MOSFET使用案例**
- **在CoolMOS™的$R_{DS(ON)}$为200 mΩ (或更高)**
- **任何具有50瓦或更高功率的同步整流级应用上OptiMOS™**

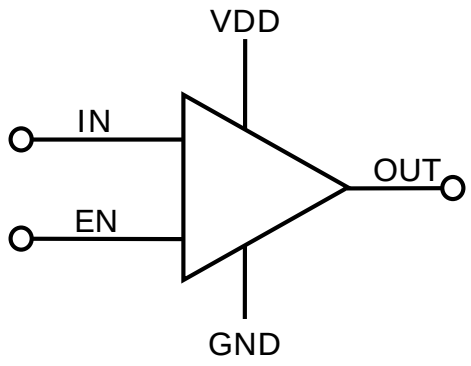
总是外部栅极驱动器IC需要



Control IC **Power FET**

具有真正差分输入的栅极驱动器IC
强大的解决方案

Conventional Low-side Gate-Driver IC



„on“ if $V_{IN\_H\ min.}$ = 2.0V

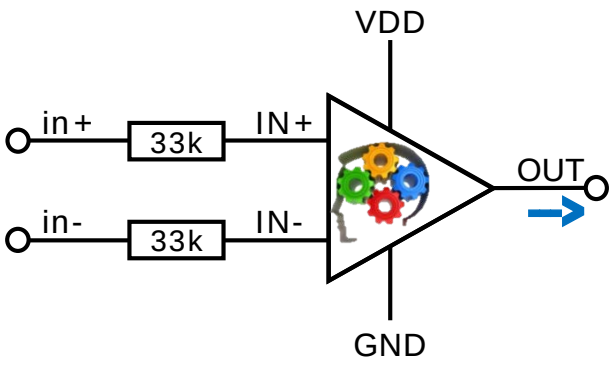
„off“ if $V_{IN\_L\ max.}$ = 0.8V

Always, versus Gate-Driver GND !

Gate-Driver IC GND-Shift may affect input level interpretation

Risk of false triggering

Low-Side Gate-Driver IC with Truly Differential Inputs



Strong driving strength: 4A/8A

„on“ if V_{IN+} minus V_{IN-} > 1.7V

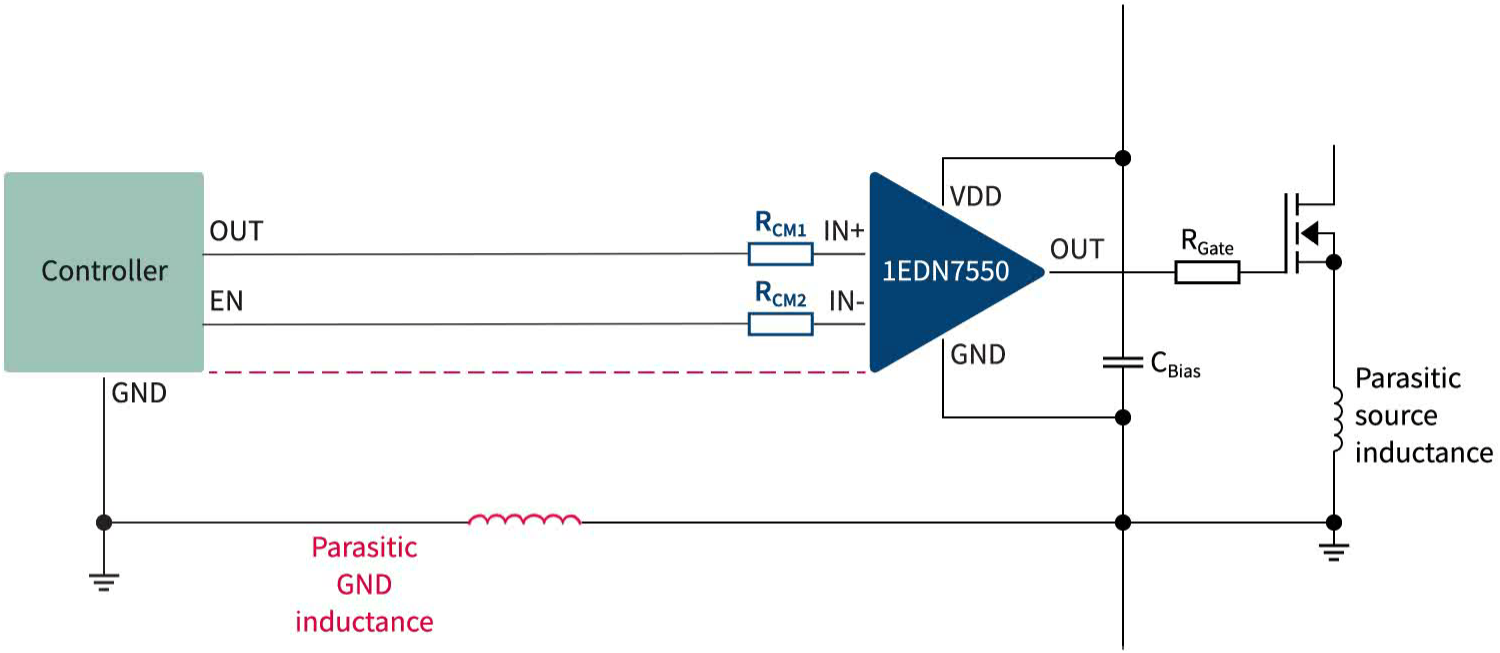
„off“ if V_{IN+} minus V_{IN-} < 1.5V

Independent from Gate-Driver GND

Robust against Gate-Driver GND-Shift +/-150V_{pk} dynamic and +/-70V static

Robust Operation

具有真正差分输入的栅极驱动器IC
强大的解决方案



Truly differential gate driver IC inputs

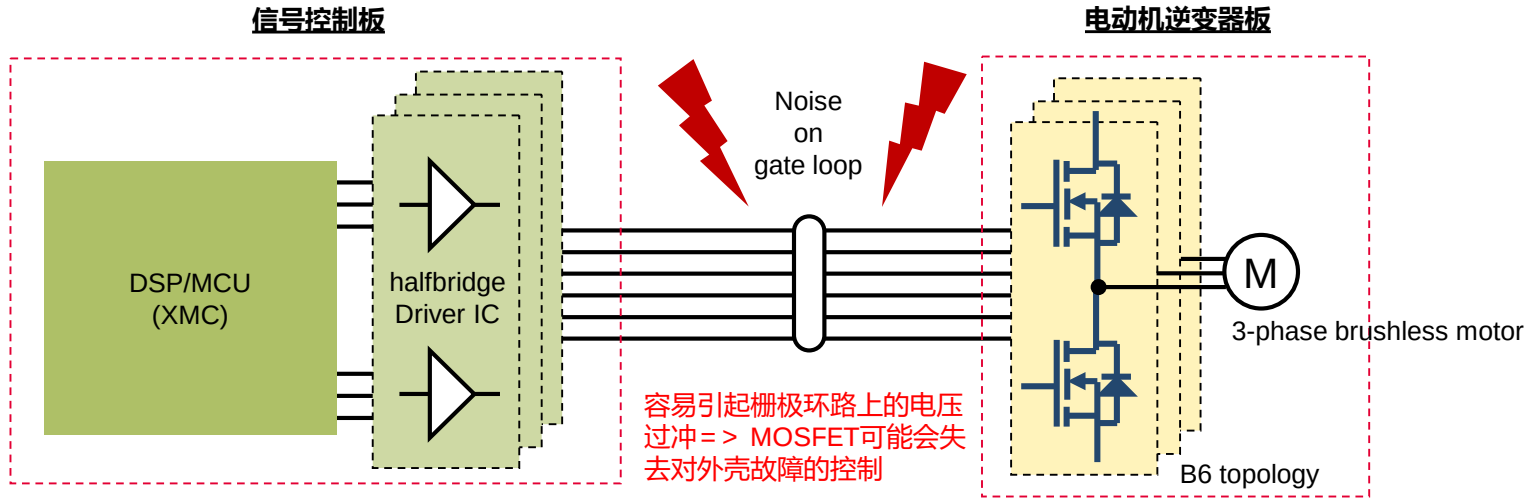
- “On” if delta between IN+ and IN- higher than 270 mV
- “Off” if delta between IN+ and IN- less than 270 mV

→ Control inputs NOT referenced to gate driver GND

No risk of false trigger

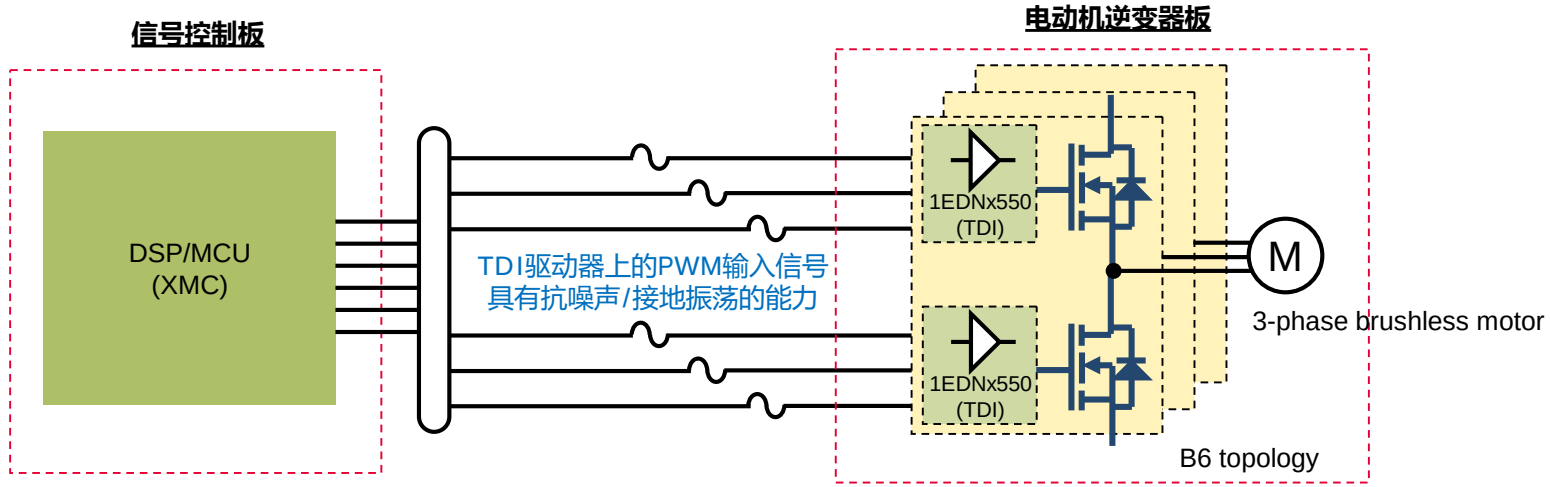
采用英飞凌1EDNx550（TDI）的半桥电机驱动

传统
驱动方案

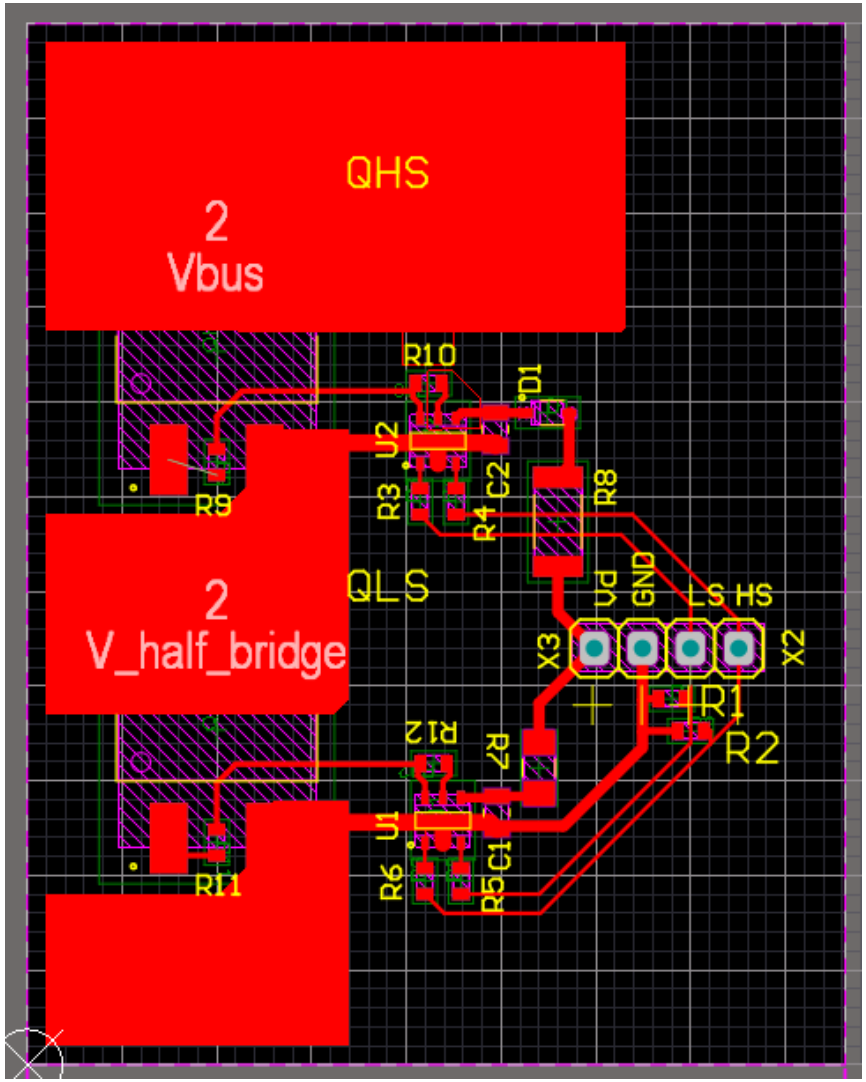


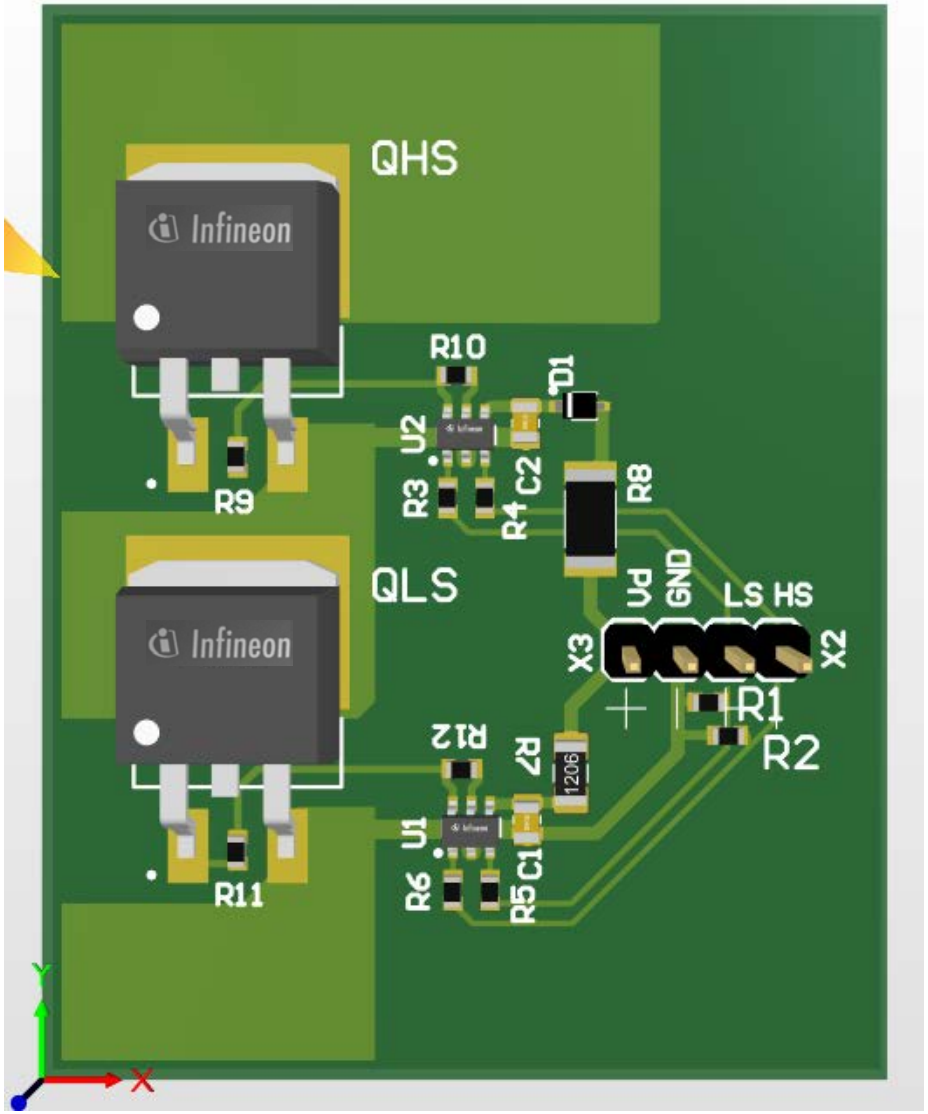
1.基于差分输入性能，驱动器对输入共同噪声具有良好的抗扰度
2.栅极环路可以大大缩短，以减少寄生效应
3.在多个MOSFET驱动的情况下，布局可以更加对称和稳健

建议
驱动方案



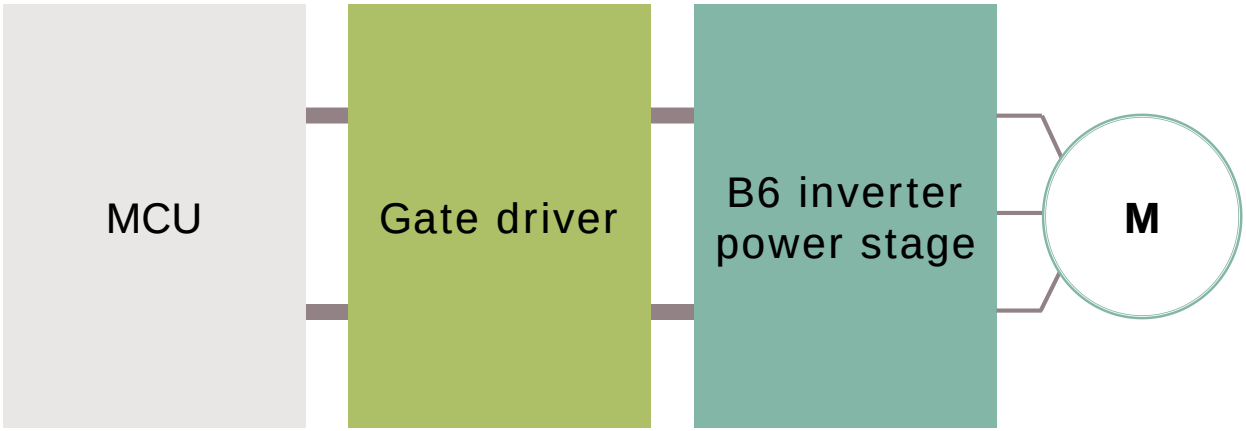
单层IMS板布局建议 - 1EDNx550（TDI）





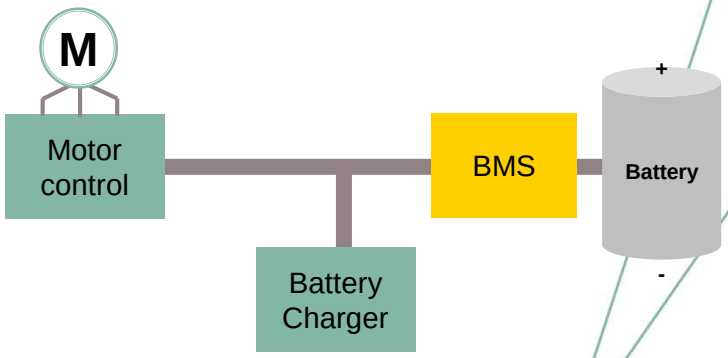
Designed by Urban

应用例子I:电机控制拓扑和推荐产品



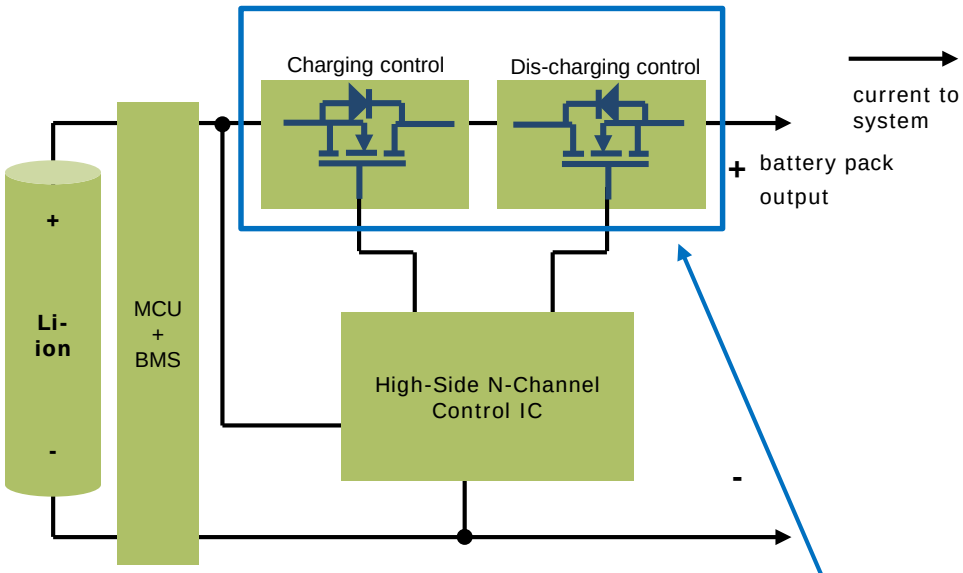
Device	IFX recommendation
B6 inverter	80V, 100 V, 150 V, 200 V OptiMOS™/StrongIRFET™
Gate driver	Half-bridge:IRS21271SPBF/2EDL23M06PJ Low-side: 1EDN7550B
MCU	XMC1300/XMC4000
Hall sensor	TLI4961//TLI5012B

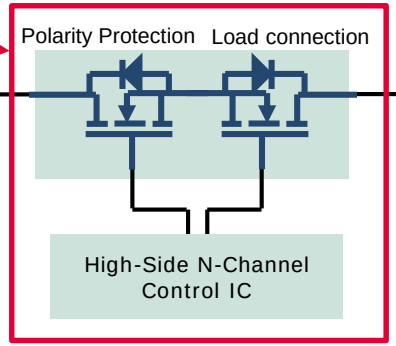
电池应用挑战性和有关方案

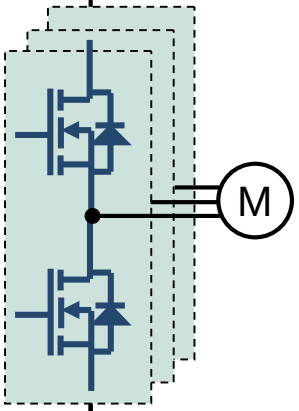


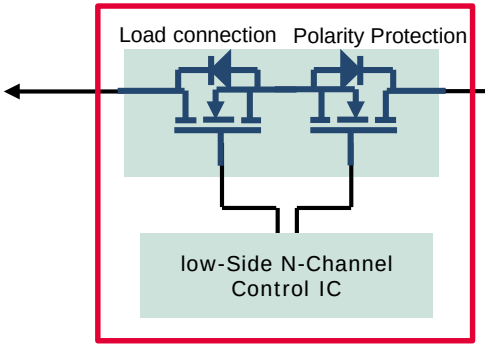
电池保护/ MOSFET负载开关

•负载开关位于电池和电机逆变器之间，目前接触器是此用途的解决方案。 MOSFET继电器与接触器解决方案相比具有成本和可靠性的优势





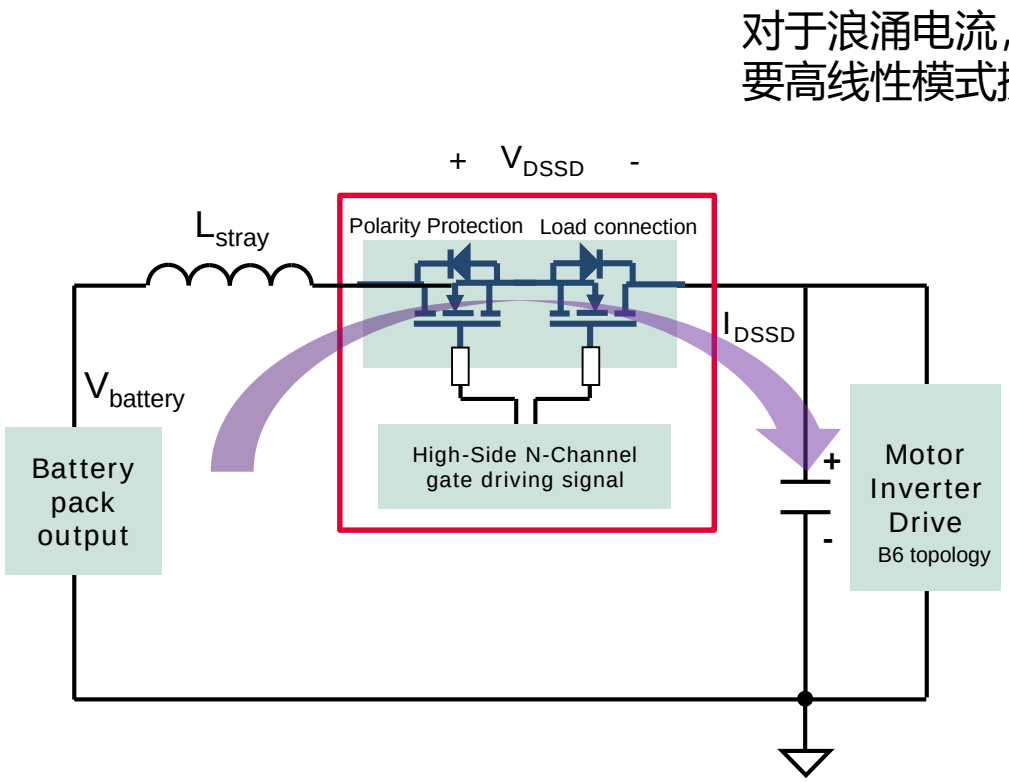


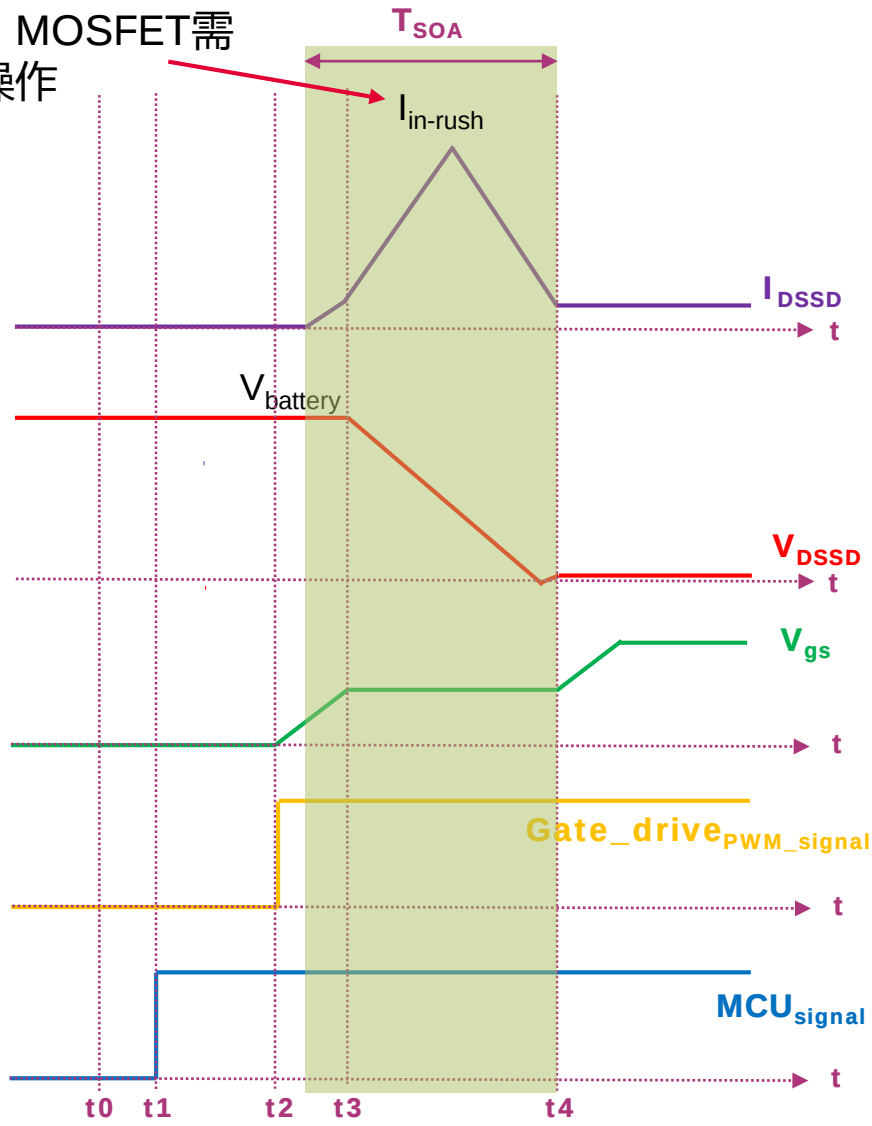


•BMS电池保护电路放置在电池组的输出端，以控制充电和放电保护功能

负载开关工作机制（软启动）

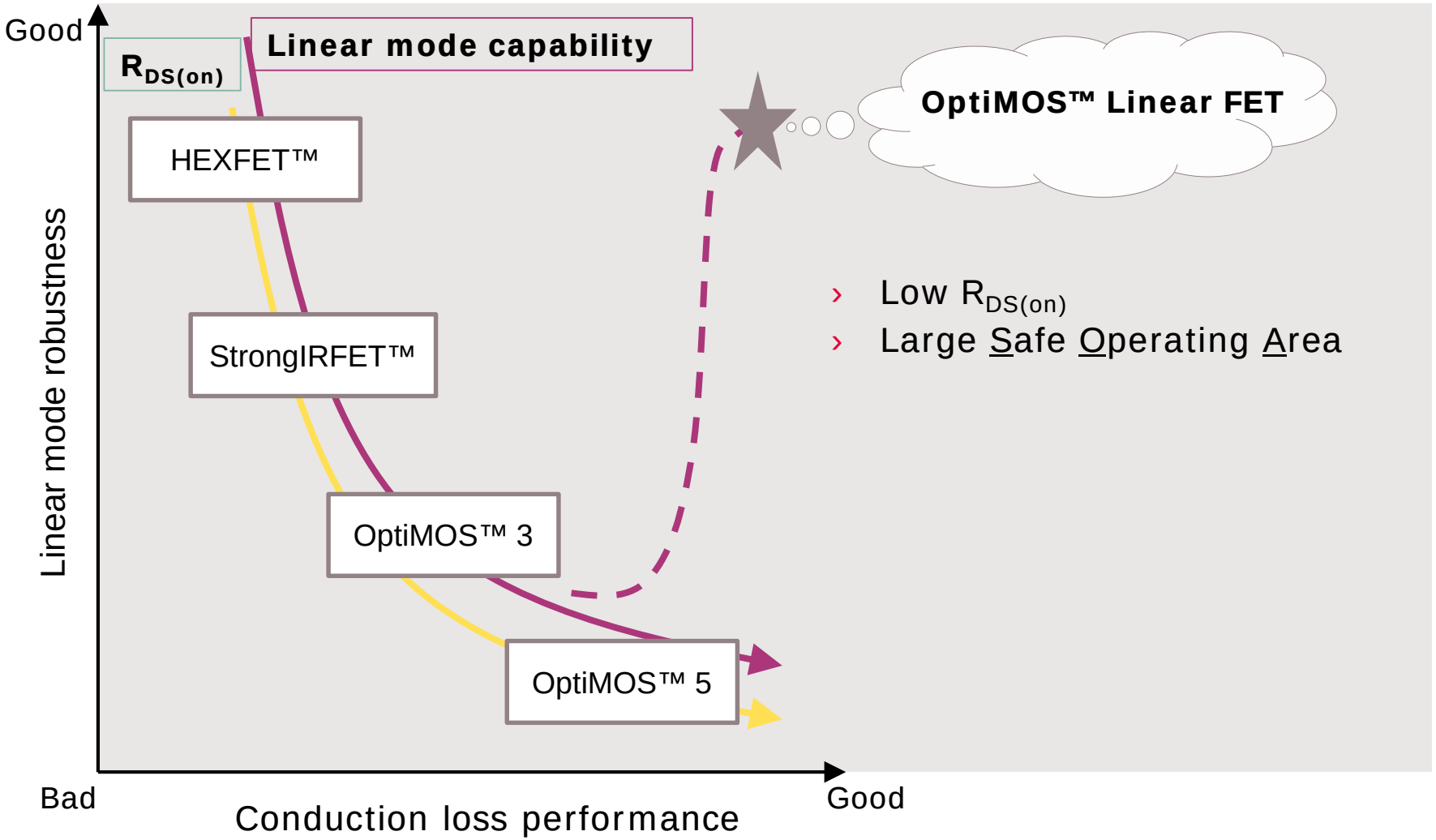
对于浪涌电流，MOSFET需要高线性模式操作





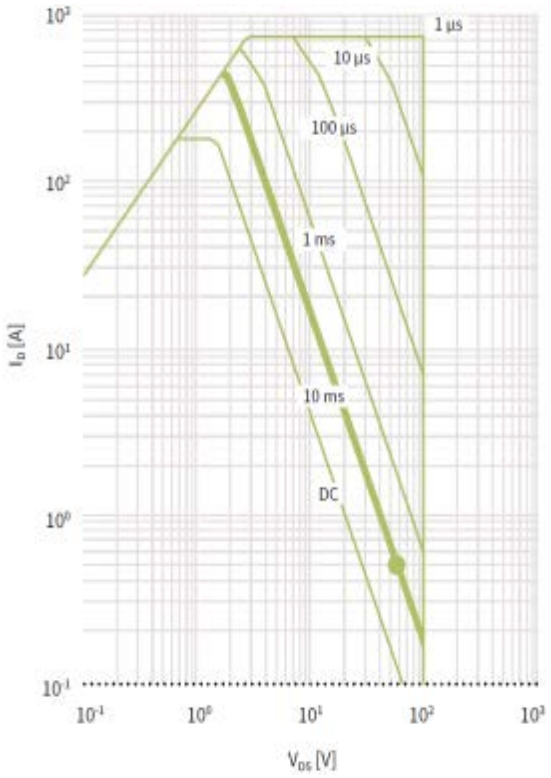
MOSFET's turn-on sequence:
t0-t1: System connection happened
t1-t2: Gate-driving signal delay
t2-t3: MOSFETs start turning-on
t3-t4: MOSFET at Millar plateau
t4: MOSFET keep turning-on

需要新的MOSFET技术来解决现代MOSFET演变的缺点



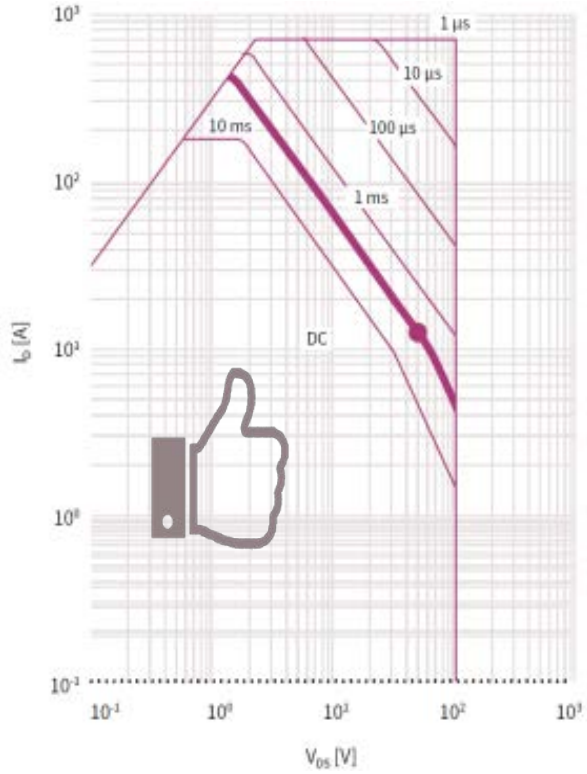
100 V OptiMOS™ LinearFET
增强的SOA和易用性

IPB017N10N5
OptiMOS™ 5



0.5 A @ 54 V, t_{pulse} = 10 ms

IPB017N10N5LF
OptiMOS™ 5 LinearFET

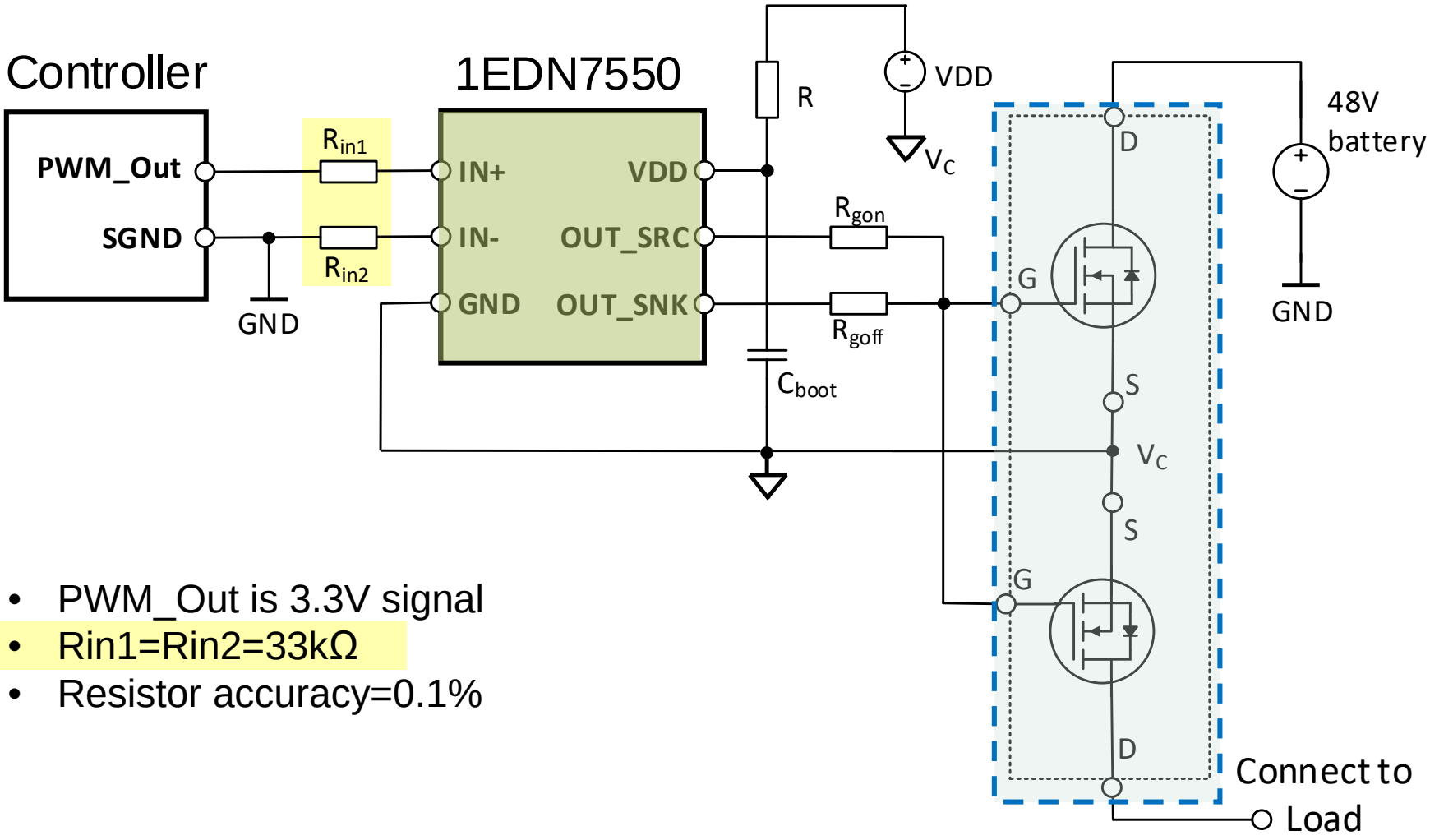


11.5 A @ 54 V, t_{pulse} = 10 ms

Key benefits

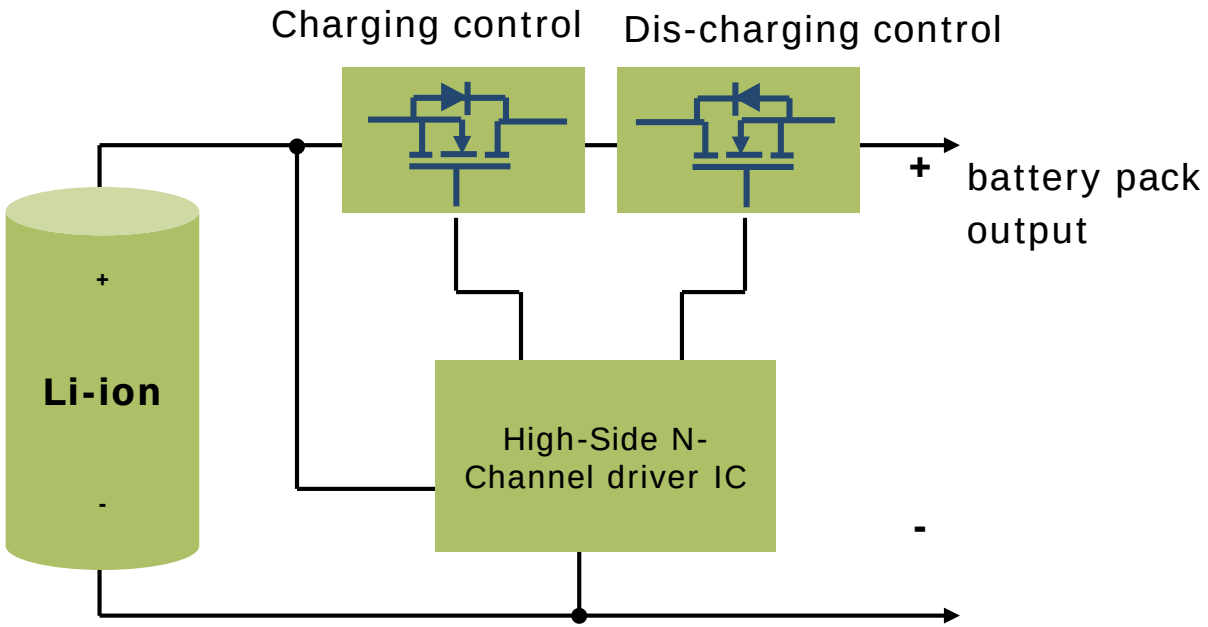
- **强大的线性模式操作**
- **低传导损耗**
- **更高的浪涌电流可实现更快的启动和更短的停机时间**
- **适用于直接替换** compatible footprint

用于48V_{dc}电池负载开关MOSFET的高端驱动器应用



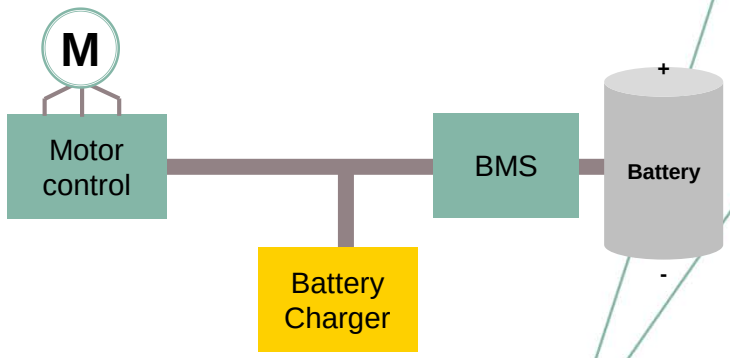
- PWM_Out is 3.3V signal
- Rin1=Rin2=33kΩ
- Resistor accuracy=0.1%

应用例子II：BMS**电池保护**拓扑和推荐产品

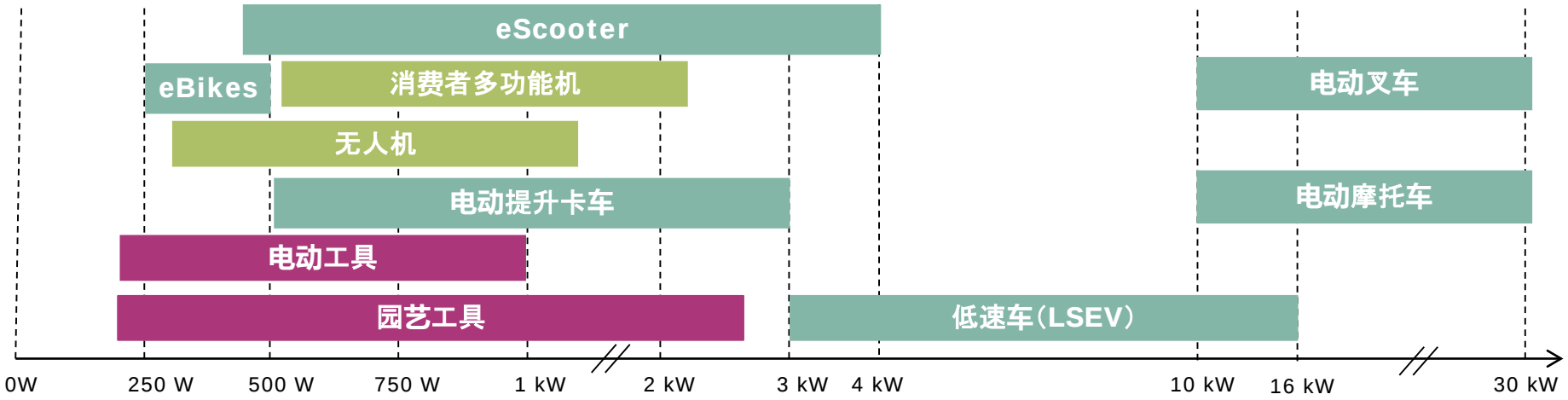


Device	IFX recommendation
Battery protection	OptiMOS™/StrongIRFET™/OptiMOS™ LinearFET
Driver IC	EiceDRIVER™ 1EDN7550B
Controller IC	XMC1000
Cell balancing	BSS314PE H6327/BSS308PE H6327

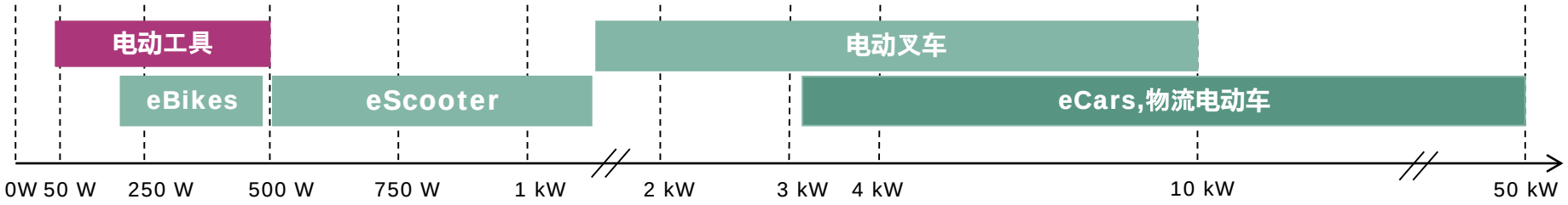
充电机应用挑战性和有关方案



电池供电的应用 - 充电器功率

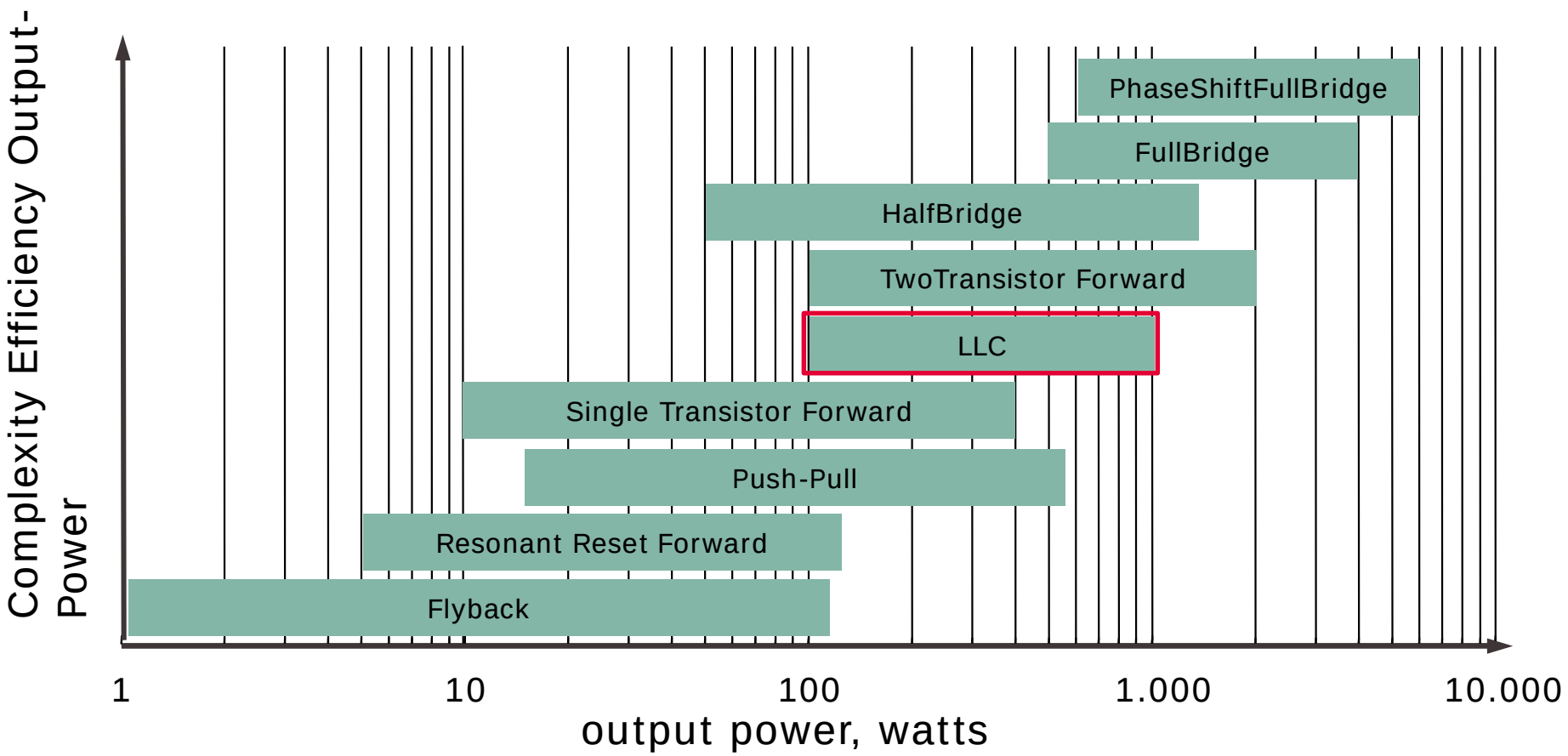


电机功率

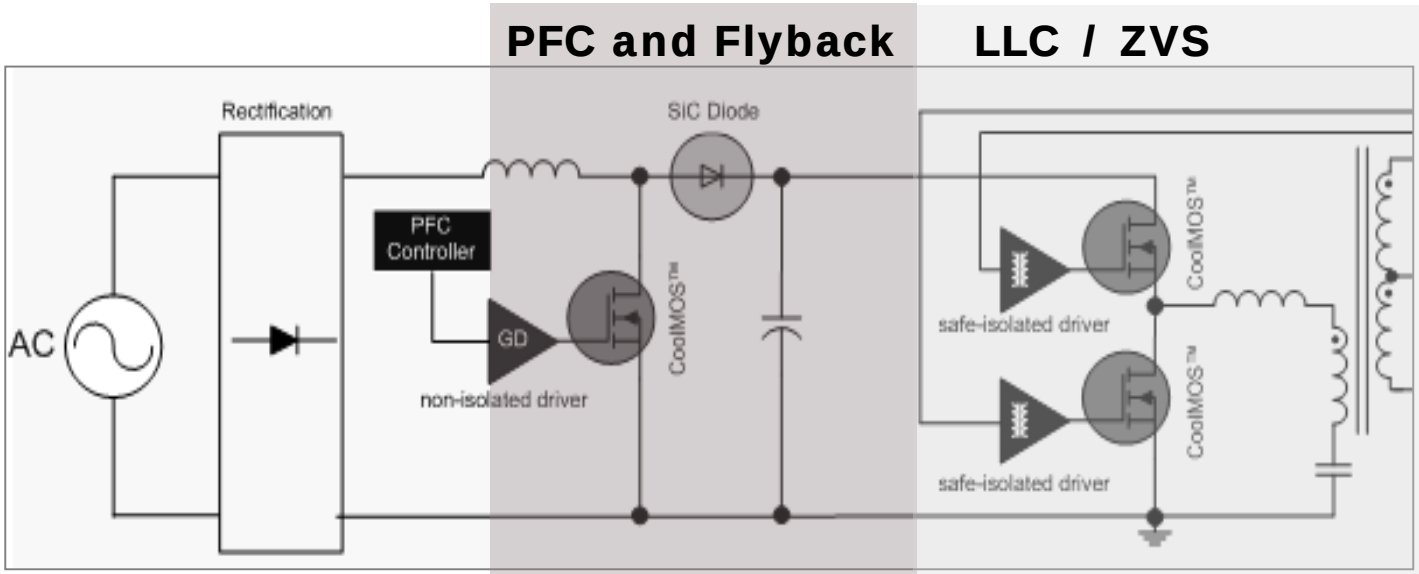


充电器功率

应用于电池充电器的开关模式电源拓扑概述



英飞凌CoolMOS™ C7, G7, P7 and CFD7定位



高性能

C7
- 效率
- 功率密度

G7

CFD7 600V
- 效率
- 快速体二极管
- 可靠性
- 耐用性

C7/600
- 效率最高
- 高端LLC

G7/600

性价比

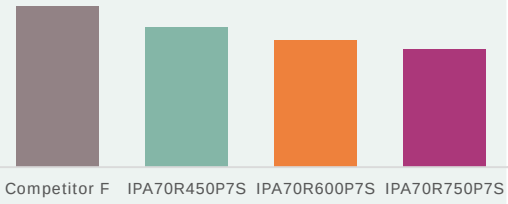
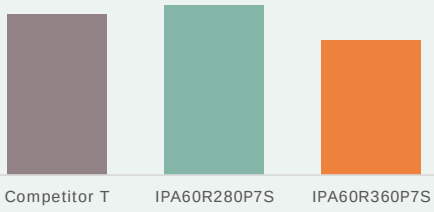
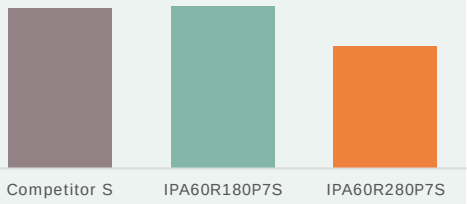
CE 500V
- 便于使用
- 成本

P7 700V/800V

P7 600V
- 便于使用
- 成本

Drive your CoolMOS™ to best performance with a cool EiceDRIVER™.

CoolMOS™ P7在于电池充电器的应用的优势

CHARGER	A	B	C
Topology	Flyback	Flyback	PFC + LLC
Input power / voltage	140 W / 230 V_{AC}	240 W / 120 V_{AC}	570 W / 230 V_{AC}
Original MOSFET	Flyback MOSFET (standard) 650 V, 440 mΩ, TO-220 FP	Flyback MOSFET (standard) 500 V, 300 mΩ, TO-220 FP	PFC & LLC MOSFET (super junction) 600 V, 180 mΩ, TO-220 FP
Infineon CoolMOS™ replacement	CoolMOS™ P7 IPA70R450P7S (700 V, 450 mΩ) IPA70R600P7S (700 V, 600 mΩ) IPA70R750P7S (700 V, 750 mΩ)	CoolMOS™ P7 IPA60R280P7S (600 V, 280 mΩ) IPA60R360P7S (600 V, 360 mΩ)	CoolMOS™ P7 IPA60R180P7S (600 V, 180 mΩ) IPA60R280P7S (600 V, 280 mΩ)
Efficiency (CoolMOS™ P7 vs. original MOSFET)	450 mΩ P7: 0.35% higher 600 mΩ P7: 0.3% higher 750 mΩ P7: similar	280 mΩ P7: 0.8% higher 360 mΩ P7: similar	180 mΩ P7: 0.5% higher 280 mΩ P7: 0.3% higher
Thermals (full load temperature of CoolMOS™ P7 vs. original)	450 mΩ P7: 13°C lower 600 mΩ P7: 6°C lower 750 mΩ P7: similar	280 mΩ P7: 11°C lower 360 mΩ P7: similar	180 mΩ P7: up to 11°C lower 280 mΩ P7: up to 11°C lower
Conducted and **radiated EMI** of CoolMOS™ P7	Pass, with margin > 6 dB	Pass, with margin > 10 dB	Pass, with margin > 6 dB
MOSFET **price** comparision			

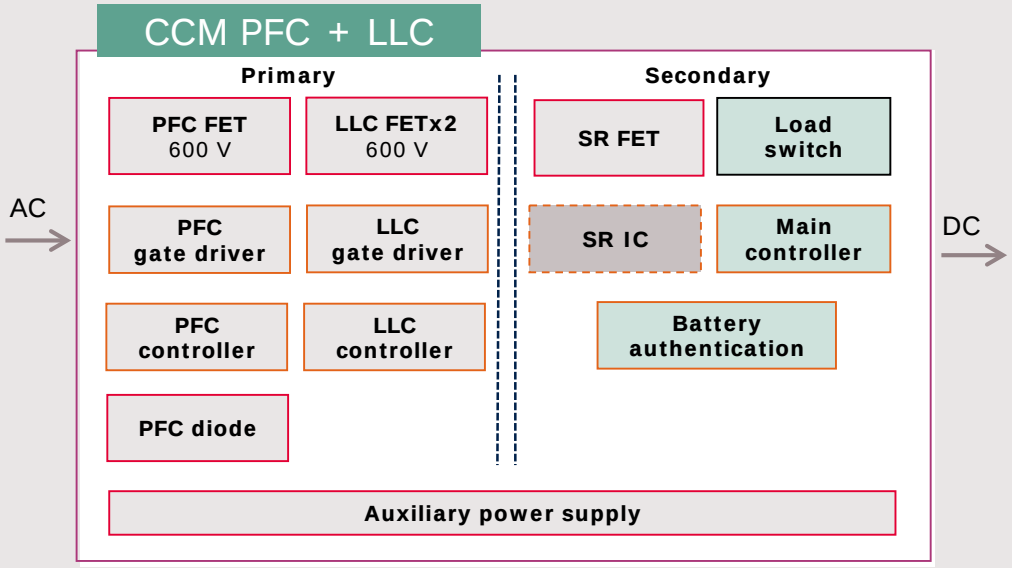
- **CoolMOS™P7在相同功率下延长了使用寿命，同时降低了MOSFET温度**
- **CoolMOS™P7允许在相同温度下增加功率**

降低BOM成本 ->采用更高 $R_{DS(on)}$的CoolMOS™ P7

Infineon solutions for high power industrial battery chargers

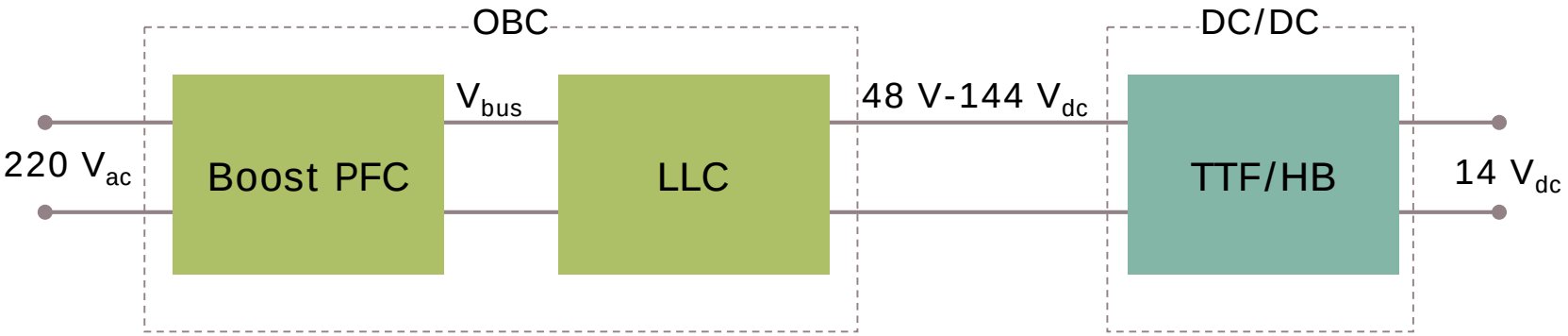
New market trends in high power chargers

- High end designs up to 1200 W
- SiC diode in PFC stage
- Gate driver for PFC and LLC MOSFETs



CCM PFC + LLC	
PFC diode	**CoolSiC™** G6 650 V
PFC FET	**CoolMOS™** P7 600 V
LLC FET	**CoolMOS™** CFD7 600 V or P7 600 V
Auxillary power supply	**CoolSET™** ICE5GR4780AG
PFC gate driver	**EiceDRIVER™** 1EDN7511B
LLC gate driver	**EiceDRIVER™** 2EDS8265H or 2EDN7524F +pulse transformer
PFC controller	ICE2HS01G
LLC controller	ICE3PCS01G
SR FET	**OptiMOS™ 5** 30 V - 150 V
Load switch	**OptiMOS™ 5** 30 V - 150 V
Main controller	**XMC™** 1200/1300
Bettery authentication	**Origa™**

应用例子III:
电池充电器和DC / DC拓扑和推荐产品



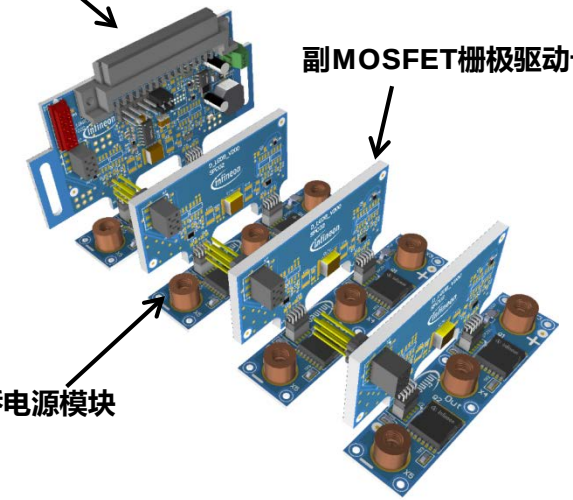
Device	IFX recommendation
PFC MOS	600 V CoolMOS™ P7/P7S
PFC Diode	650 V CoolSiC™ Gen 6
PFC gate driver	EiceDriver™ 1EDN/2EDN
LLC MOS	600 V CoolMOS™ P7/CFD7
LLC gate driver	EiceDriver™ 1EDN/2EDN
TTF/HB MOS	100 V-250 V OptiMOS™/StrongIRFET™
Controller IC	XMC4000

英飞凌用于中低压电池供电的大电流电机驱动演示板

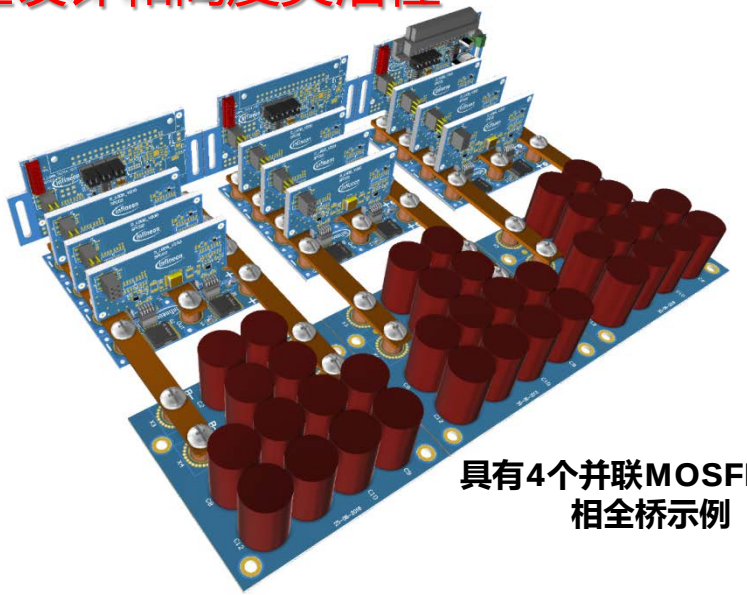
英飞凌用于中低压电池供电的大电流电机驱动可扩展演示组件
80-250V MOSFETs

快速原型设计和高度灵活性

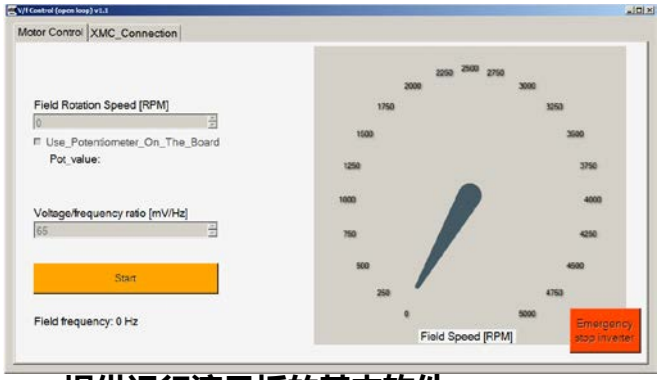
半桥电源模块



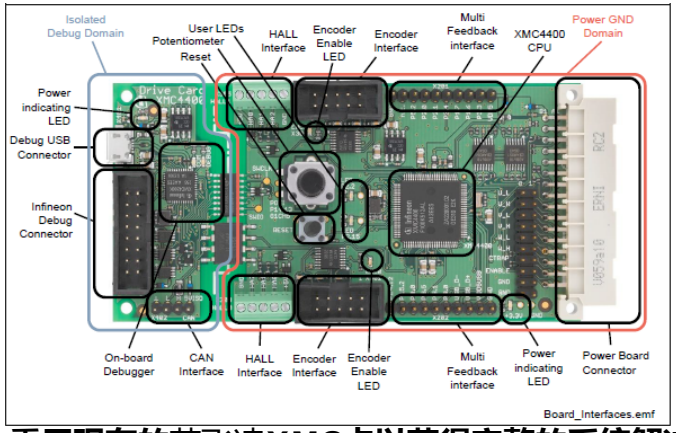
单相 (single-phase)构建块



具有4个并联MOSFET的3相全桥示例



提供运行演示板的基本软件



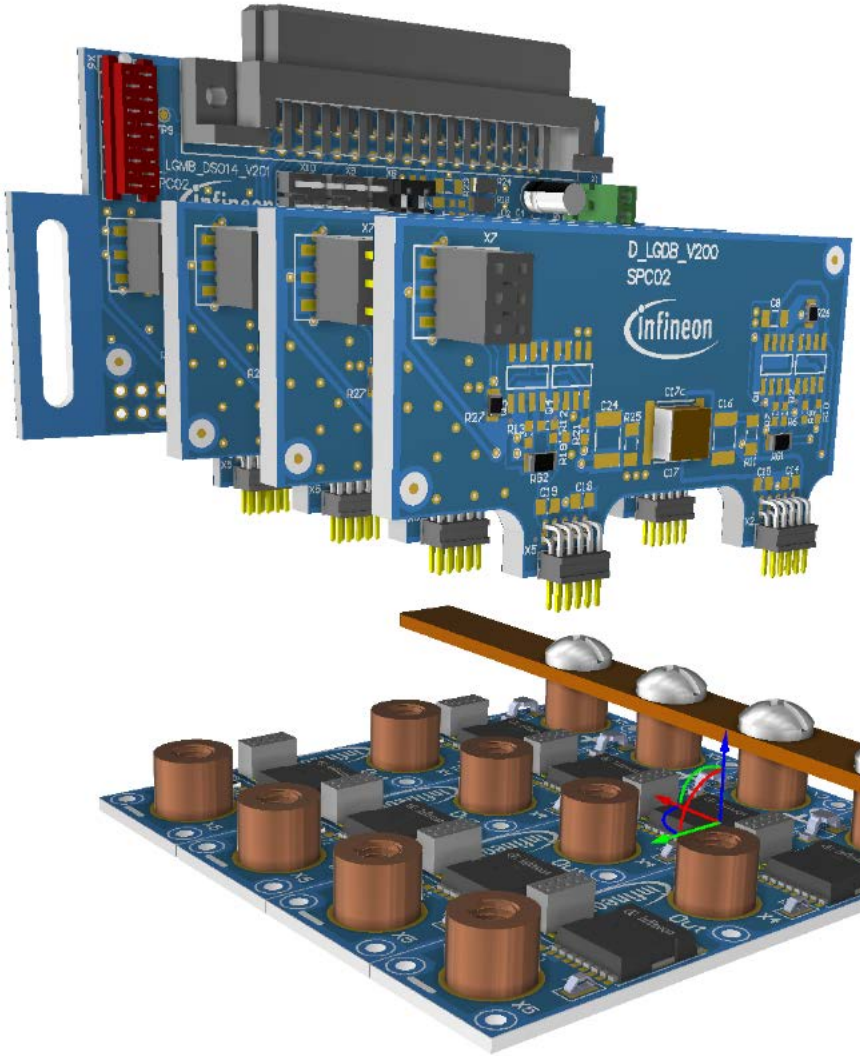
重用现有的英飞凌XMC卡以获得完整的系统解决方案

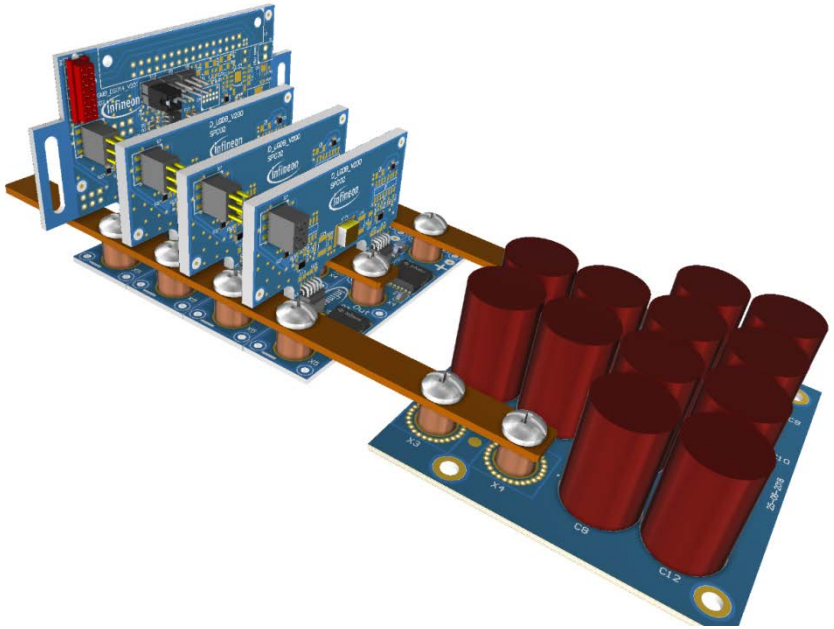
Availabe PN#:

Power PCB:
IPT012N08N5
IPT007N06N
IPB017N10N5
IPB044N15N5
IPB107N20N3
IPB117N20NFD
IPB200N25N3

Gate Driver
2EDL23N06

四个MOSFET并联示例PCB组装图





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产品手册

- Product Briefs
- Selection Guides
- Application Brochures
- Presentations
- Press Releases, Ads

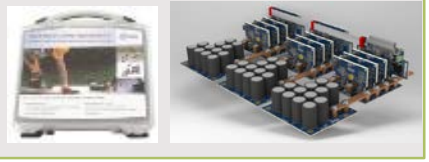
- https://www.infineon.com/cms/en/product/power/mosfet/20v-300v-n-channel-power-mosfet/
- www.infineon.com/toll
- www.infineon.com/smallsignal
- www.infineon.com/xmc
- www.infineon.com/eicedriver
- www.infineon.com/powermanagement-selectionguide

技术资料

- Application Notes
- Technical Articles
- Simulation Models
- Datasheets

- www.infineon.com/optimos-lowvoltage
- www.infineon.com/optimos-mediumvoltage

评估板



- Evaluation Boards
- Demoboards
- Reference Designs

- www.infineon.com/motorcontrolapplicationkit
- https://www.infineon.com/cms/en/product/promopages/lv-drives-scalable-power-demoboard-platform/?redirId=103443

视频

- Technical Videos
- Product Information Videos

- www.infineon.com/mediacenter

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