英飞凌智能LED照明方案

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英飞凌科技（中国）有限公司

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  - XDPL8221：PFC+Flyback,限功率,极低待机，通讯功能
- DC/DC LED驱动 ILD8150/BCR60X/BCR系列
- 高效可靠的CoolMOS™ P7系列

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AC/DC 照明方案

CCM PFC + Resonant	CCM PFC+LLC(> 200W)	ICE3PCSXX ICE1HS01G
DCM PFC + Resonant	集成PFC+LLC/LLCC	ICL5102/5102HV
Boost PFC+QRC	高PF，低THD,零件少，成本低	TDA4863/IRS2505 ICE2QS02/03G XDPL8221
Single Stage PFC/Flyback	IRS2505	超小型（SOT23-5）电路简单
	IRS2982S	高PF,低THD,低待机功耗
	XDPL8105/8218(digital solution)	数字控制，低功耗,低THD
	TDA4863	低THD

数字电源

数字电源

5W 25W 50W 100W 300W+

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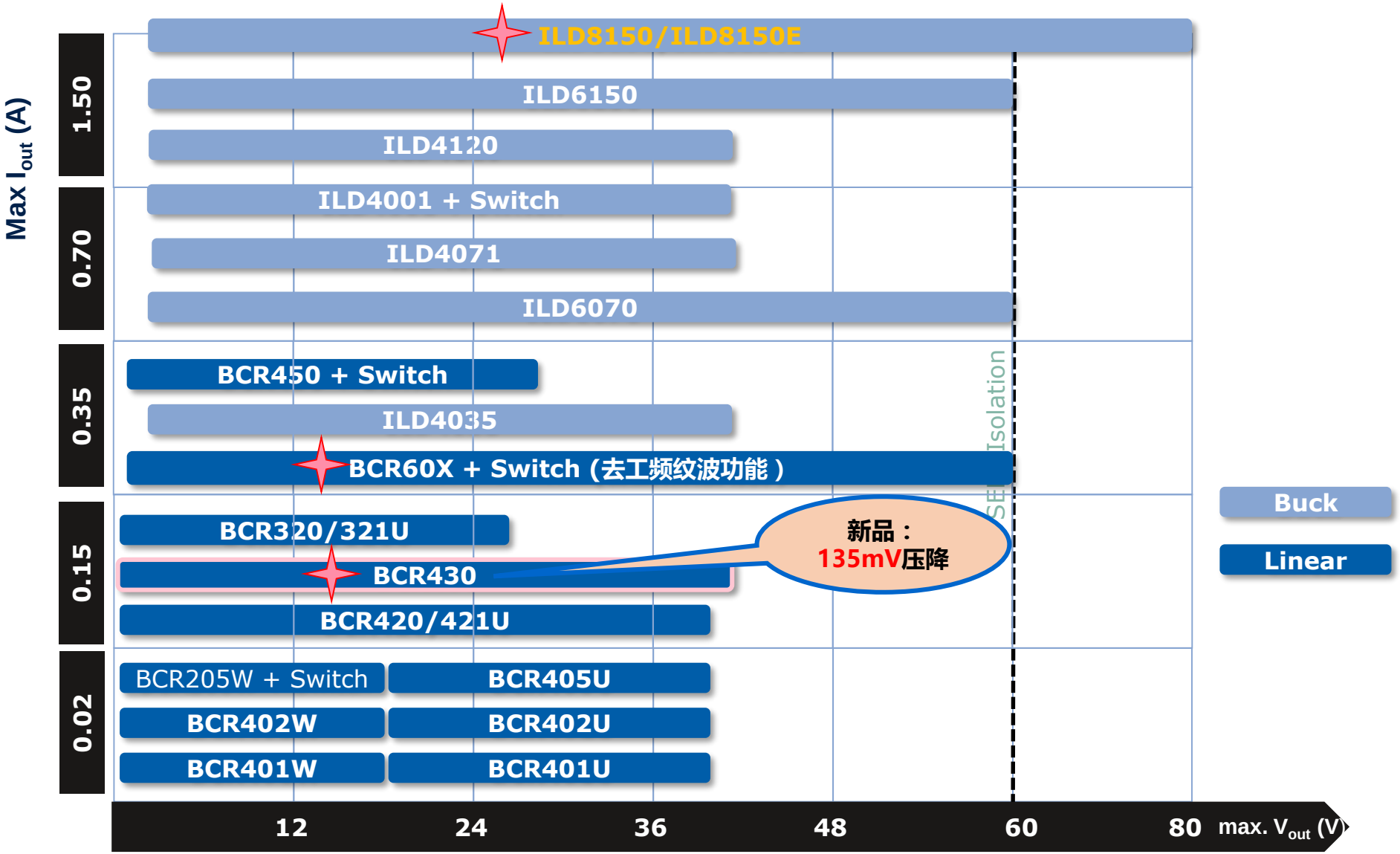
DC/DC LED 驱动方案



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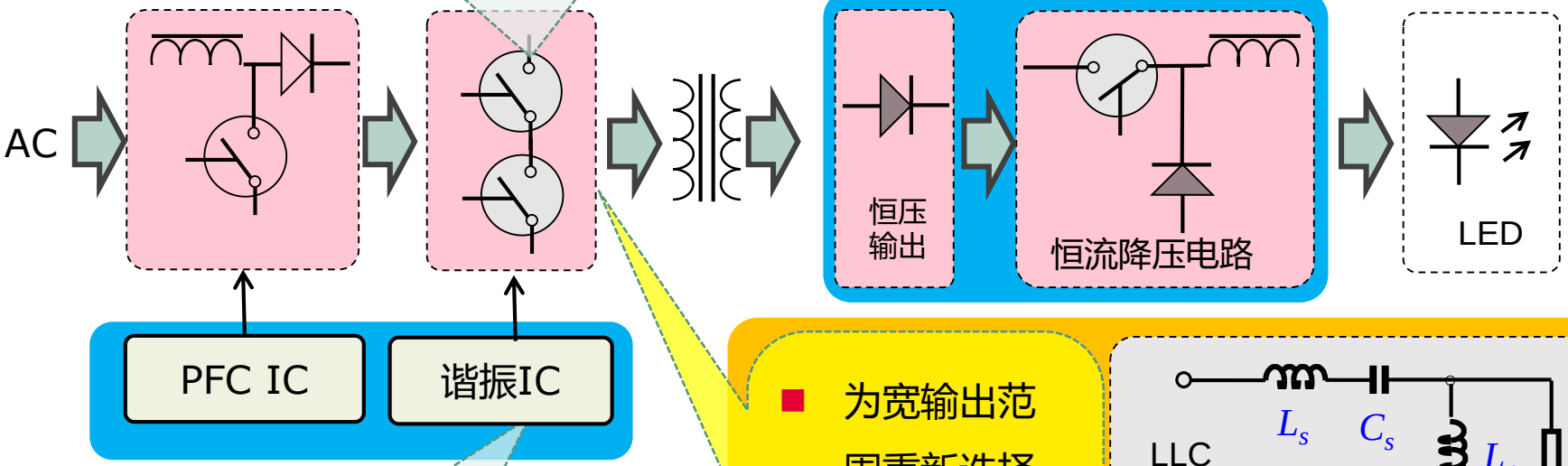
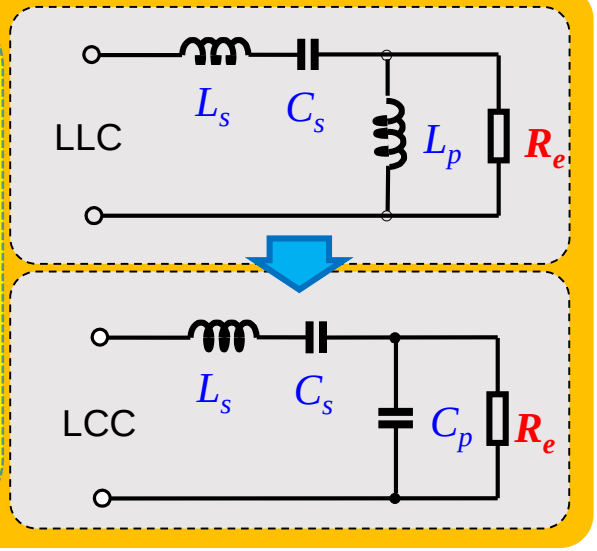
对传统PFC+谐振LLC的优化

- 采用低损耗，小封装开关管 CoolMOS™

- 直接恒流输出



- 为宽输出范围重新选择谐振拓扑 LCC



- 采用16 脚高集成ICL5102
- 采用20脚高集成ICL5102HV

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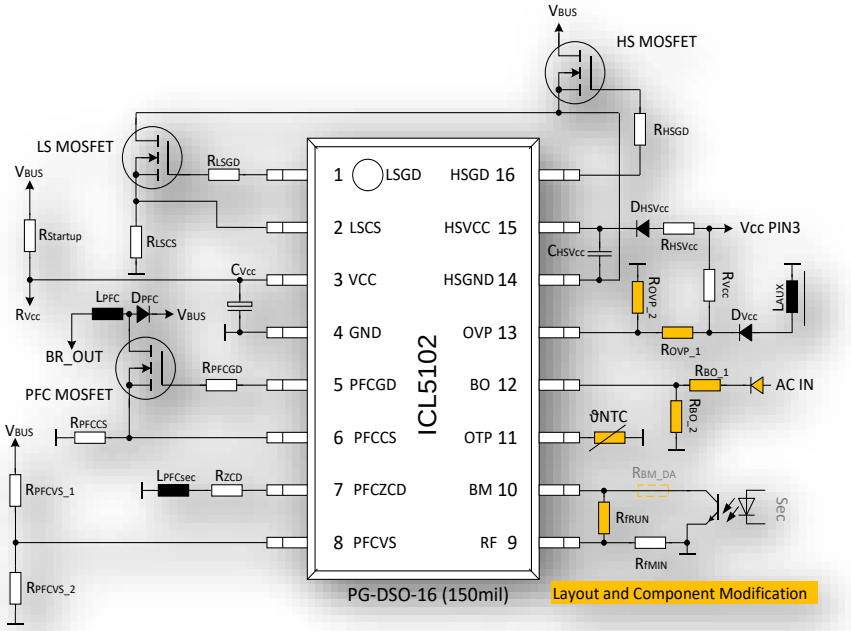
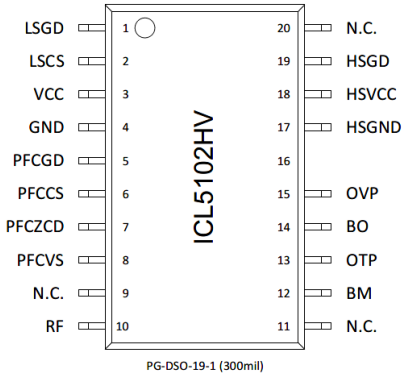
PFC+谐振半桥 控制器ICL5102/ICL5102HV

- SO-16,集成CRM PFC+半桥谐振控制
- PF>**95%**， THD<**10%**
- 集成650V/900V耐压高压驱动
- 全保护功能（外部OTP，容性检测等）
- 所有参数均由电阻设置
- 结温范围：-40°C~125°C

- 有间歇模式，低待机功耗
- 集成输入欠压保护
- 过温保护精度更高
- 频率范围更宽 25KHz—500KHz
- ICL5102HV（SO-20）可支持更高输入电压如480VAC





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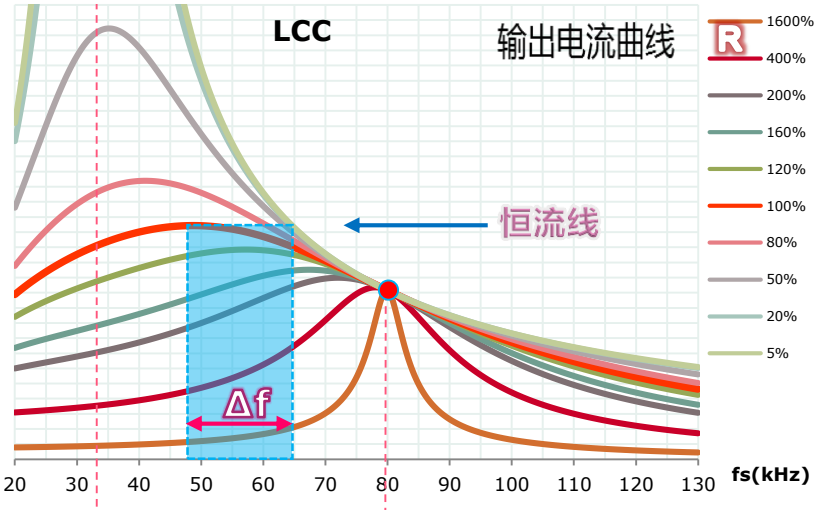
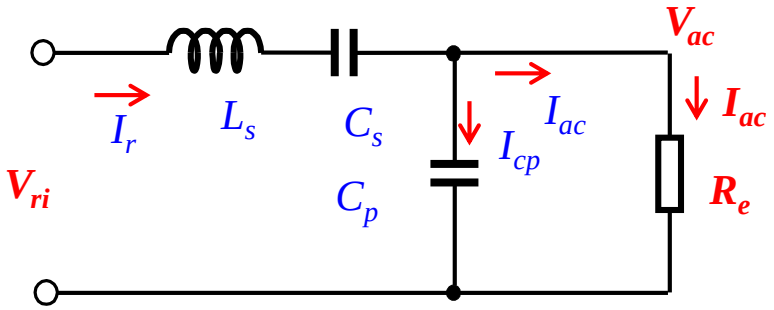
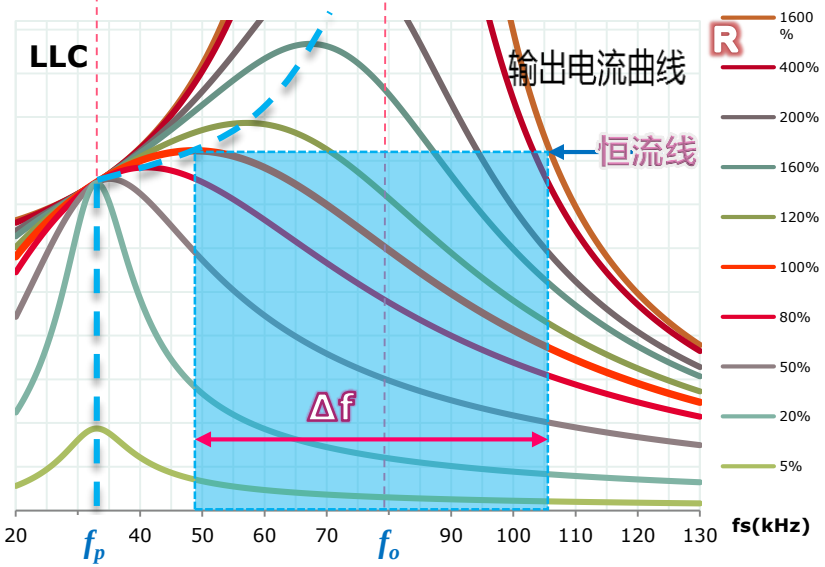
LCC拓扑的特点

- 在**较窄的频率范围**内实现很宽的输出电压范围
- 在**较窄的频率范围**内实现恒流
- 相对于LLC，LCC具有较好的短路特性
- 谐振点的输出电流恒定，**无次级反馈**情况下可以实现恒流



LCC拓扑





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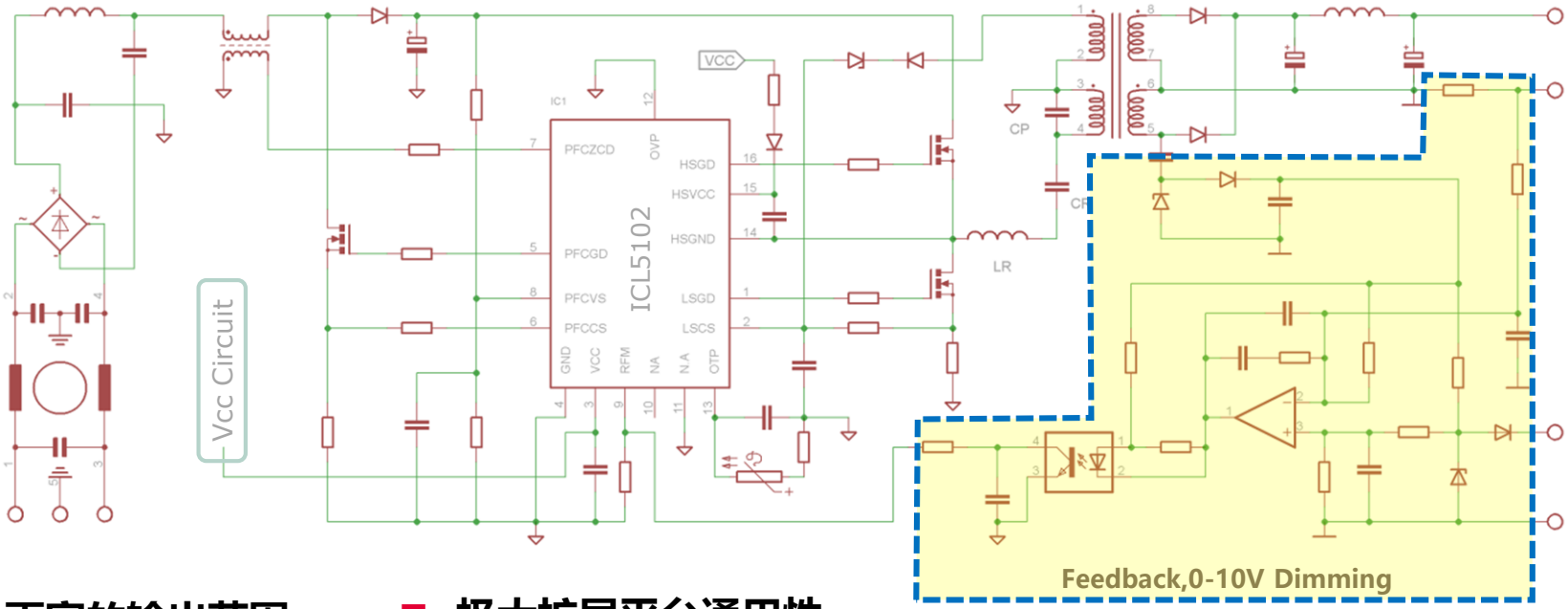
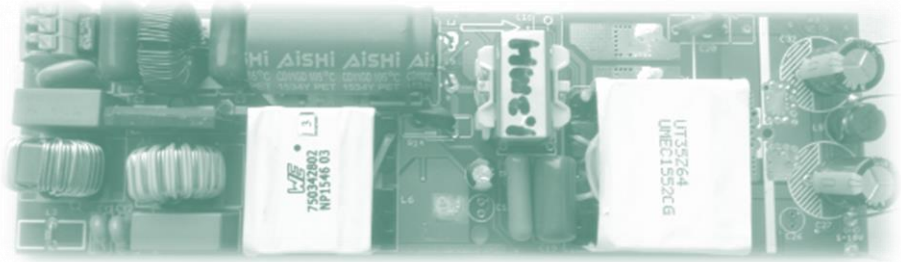
120W LCC 宽输出电压电流范围驱动方案



- **更宽的输出范围**
  - ✓ 电流: 低至2%
  - ✓ 电压: 低至 20%
- **极大扩展平台通用性**
  - ✓ 缩短研发周期
  - ✓ 减少库存
  - ✓ 加快产品上市时间

Item	Spec
Input(Vac)	90-277
Vout(V)	10-80
Iout(A)	0.05-1.5

Vac(V)	Vout(V)	Iout (A)	Eff
230	80	1.5	**93.3%**
90	80	1.5	90.9%



IC	PFC MOSFET	LCC MOSFET
ICL5102G	IPD60R180C7	IPD60R650CE

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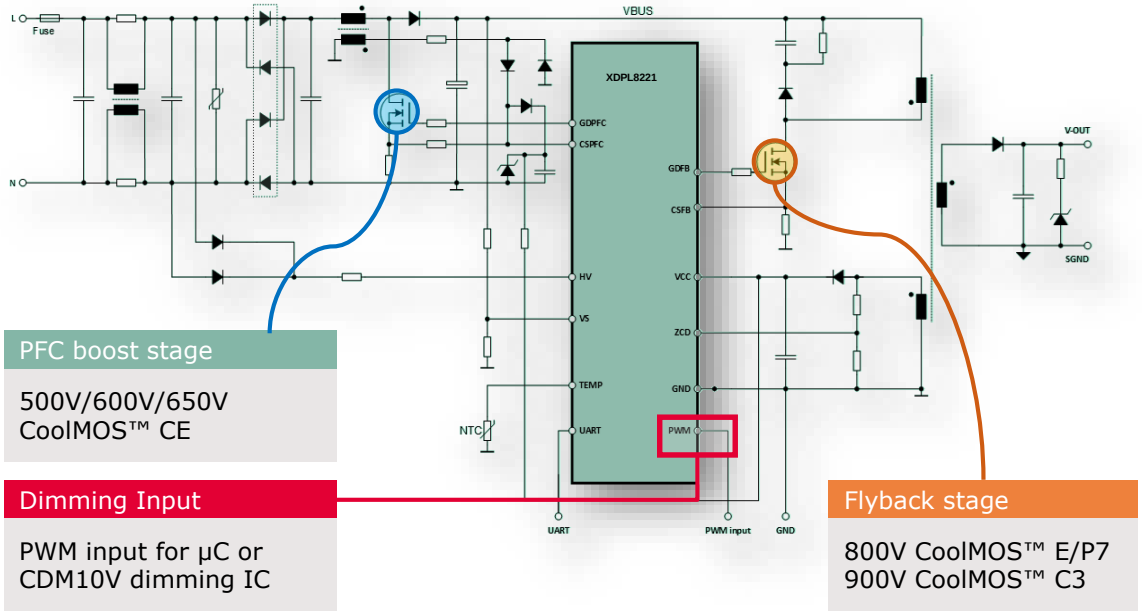
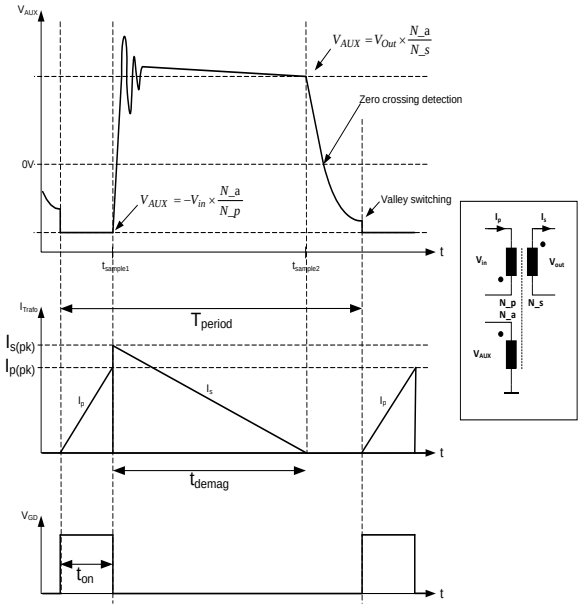
XDPL8221 PFC+QR

- 集成了QR PFC和QR Flyback
- SO-16 封装，原边控制（PSR)
- 待机可低达70mW
- 恒压，恒流，恒功率（**限功率**）模式
- 可设置不同调光曲线，PWM调光脚
- 系统参数可编程
- XDPL8221的UART 通讯口与外界**实时通讯**
- XDPL8221可以低至1%深度调光，并支持光调灭
- 优秀的THD性能
- 全面系统保护





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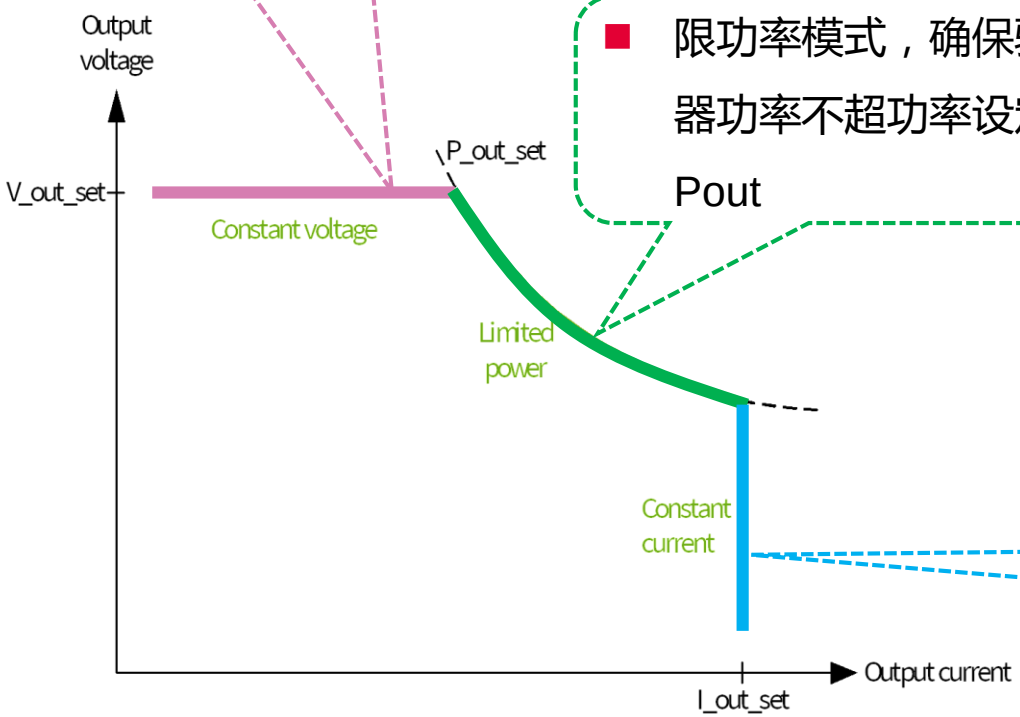
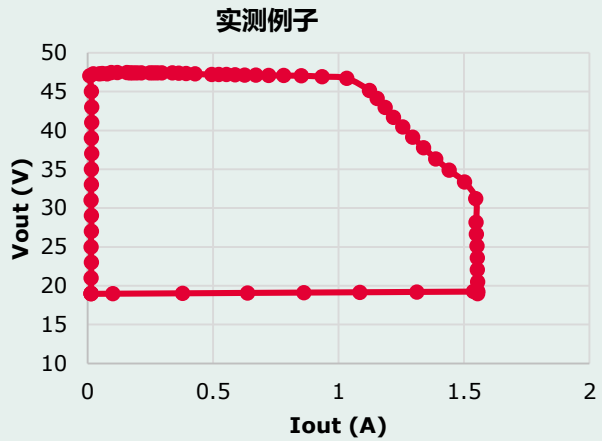
多重工作模式：恒流，恒压，限功率

- 恒压模式， Vout 输出给后级，例如BCR 线性调节器或DC/DC buck ILD8150

- 限功率模式，确保驱动器功率不超功率设定 Pout

- 恒流模式，输出设定的 Iout 给负载





- 测试基于50W演示板，输出16V~48V/1.5A
- 最低电流输出10mA - 15mA

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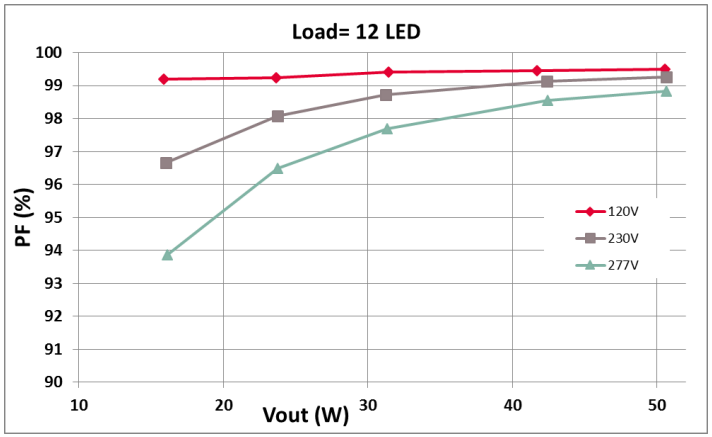
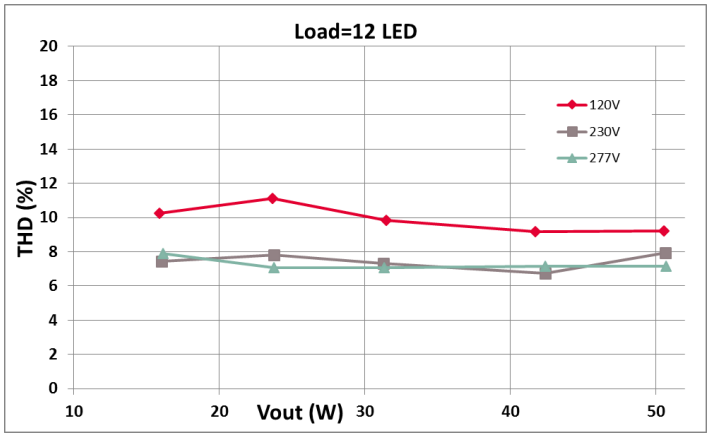
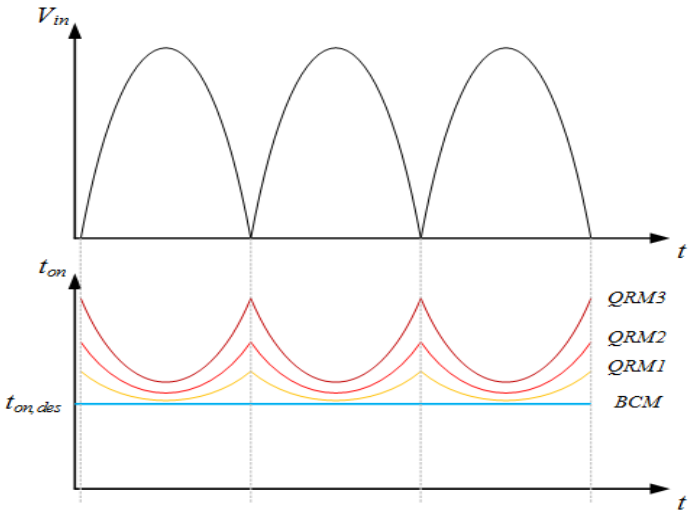
输入保护及THD优化

- XPDL8221 检测输入电压，具有输入过压/欠压保护功能
- XDPL8221 同步交流输入，执行THD优化







实测性能：
PF > 90% and THD < 15% @低至15%负载

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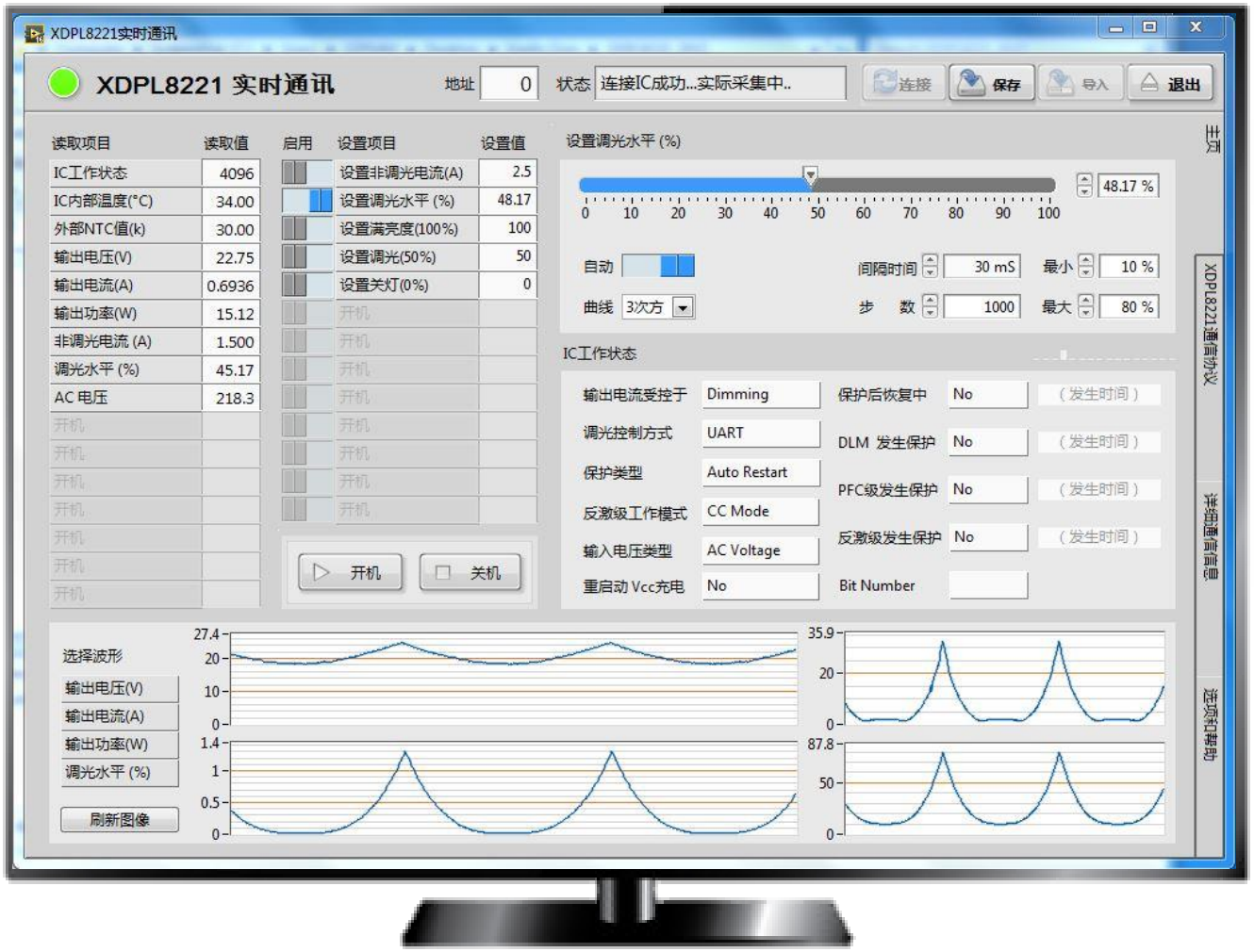
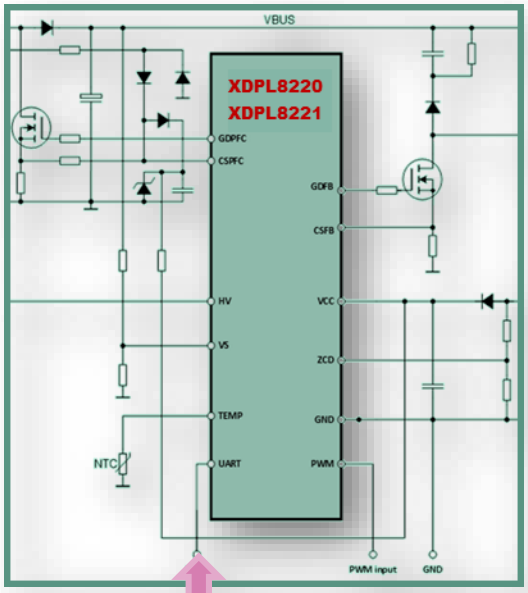
XDPL8221 实时通信

- XPDL8221可通过UART接口实现实时控制和读取数据及状态
- 便于扩展到智能照明，连接云端应用实现远程通讯与控制

XDPL8221???? 2018_01_14 10_15_27.mp4





UART Interface

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保护功能

PFC 保护

Failure	Con-figurable
Bus Over Voltage Level 1 (Firmware)	No
Bus Over Voltage Level 2 (Hardware)	No
Input Under voltage	No
Input Over Voltage	Yes
PFC Over Current Level 1	No
PFC Over Current Level 2	No
PFC Soft-start Failure	No
PFC CCM	No
Bus Voltage Plausibility Check	No

Flyback 保护

Failure	Con-figurable
Flyback Over Current level 2	No
CSFB Short to GND	No
Output Under Voltage	Yes
Output Over Voltage	Yes
Output Over Current	Yes
Output Over Power	Yes
Flyback CCM	No
Max Tosc exceeded	No

其他保护

Failure	Con-figurable
Vcc Over Voltage	Yes
Vcc Under Voltage	No
External Temperature Exceeded	Yes
Internal Temperature Excedded	Yes

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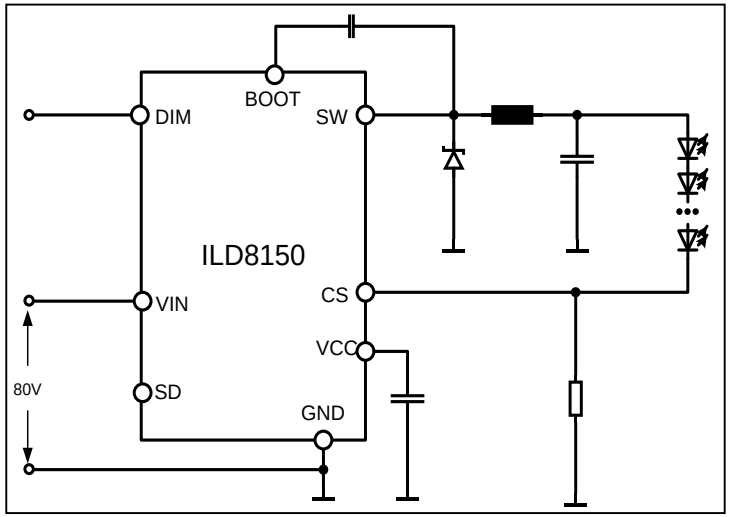
DC/DC 开关降压型LED驱动 ILD8150

典型特点

ILD8150特点：

- 输入电压范围从8 V到80 V
- 内部集成高端开关管，最大支持1.5A恒流输出
- 效率> 95%
- 电流精度± 3%
- 工作频率最高达2MHz
- 内置MOSFET导通阻抗为275 mΩ
- 具备软启动功能
- 外部电流采样，可通过此电阻设置恒流电流值
- 具备使能脚，支持外部信号关机
- 过温保护, 门极驱动欠压保护



调光特性

- PWM脚输入频率范围250Hz—20KHz
- 模拟调光范围100% - 12.5%
- 从12.5%至0.5 %之间，此时输出为方波状态，以3.4KHz的方波信号来调光
- 支持调灭
- 内置下拉晶体管避免LED在调灭状态下出现闪烁

应用在：
LED驱动器
LED 光引擎/模块
多通道照明
调色

2种封装：
DSO-8
DSO-8 exposed pad
(ILD8150E)

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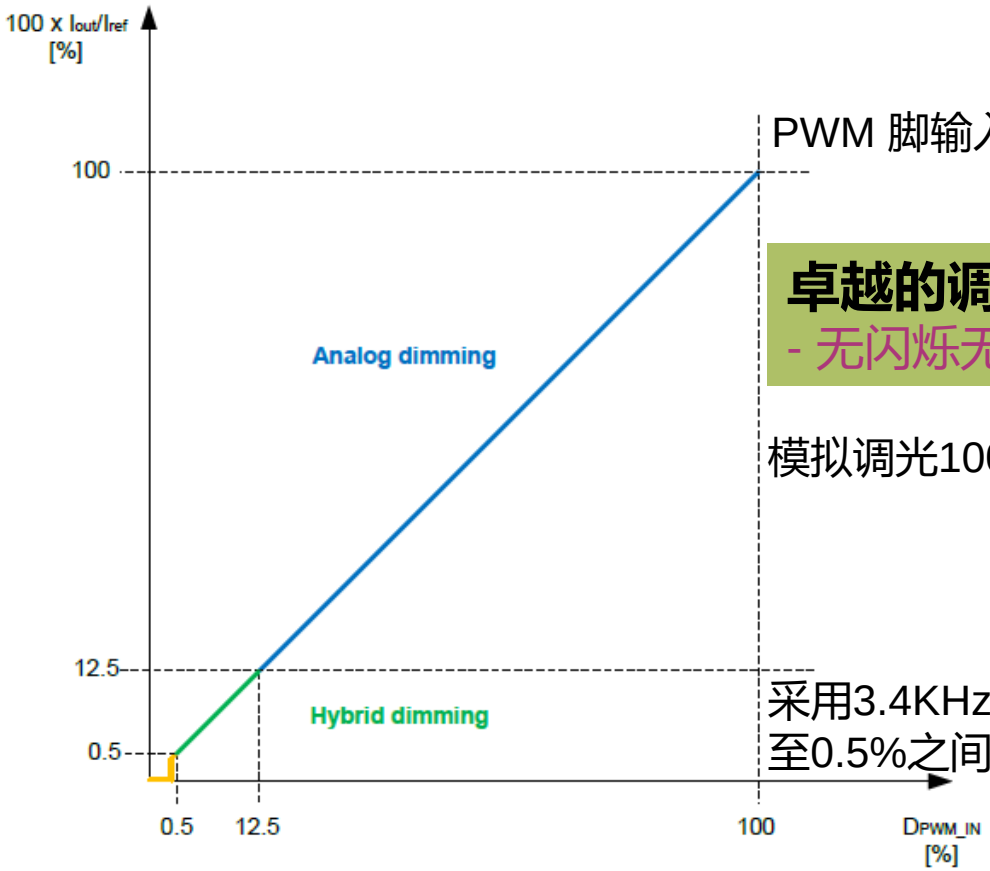
ILD8150 卓越的调光性能

ILD8150 混合调光曲线



PWM 脚输入调光频率在250 Hz 到 20 kHz 之间

卓越的调光性能
- 无闪烁无噪音

模拟调光100% - 12.5%

采用3.4KHz无闪烁调制，数字调光状态从12.5%至0.5%之间。

支持调灭
内置下拉晶体管可避免调灭时出现闪烁

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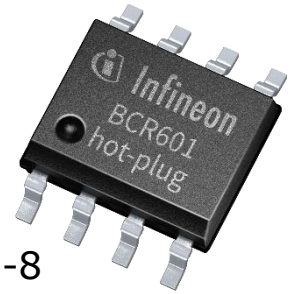
60V线性恒流控制器—去工频纹波系列

BCR601
(反馈功能 + 热插拔+ 模拟调光)



DSO-8

目标应用: LED 驱动器

次级反馈功能
过压保护, 3% 模拟调光

BCR602
(热插拔 + 数模混合调光)

SOT23-6

目标应用: LED 模块

3% 模拟调光深度, 1% 数字调光深度

BCR60x 家族特点

- 输入电压范围8 V -- 60 V
- 100 Hz/120 Hz 工频纹波抑制
- LED电流精度±3%
- 过温保护
- 支持驱动三极管或者MOSFET
- 热插拔保护
- R-set 功能
- 元件数量少

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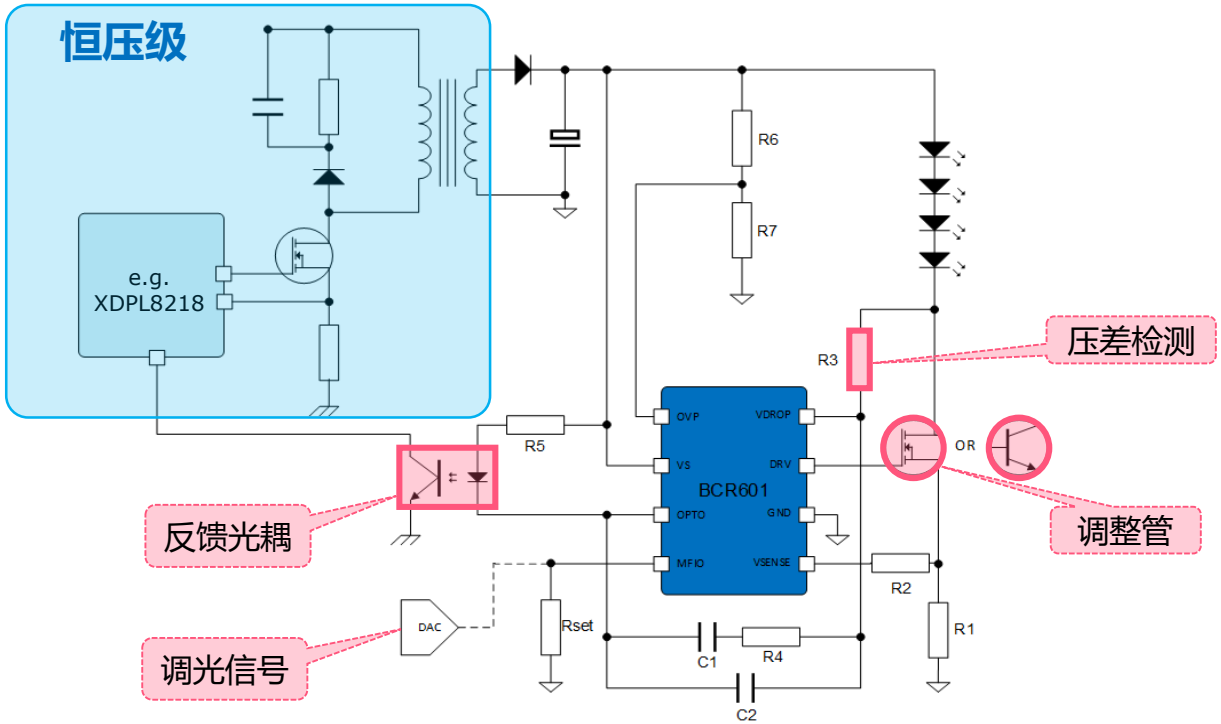
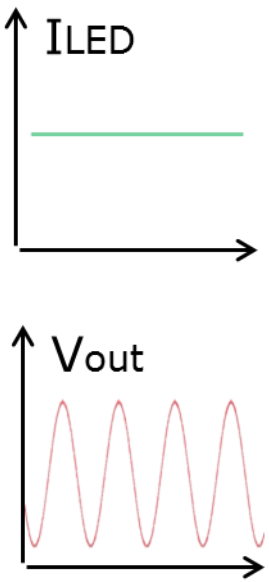
BCR601：高效率，去纹波，对接稳压输出





- 线性恒流去纹波
- 支持8-60V供电
- 支持NPN三极管和N型MOSFET
- 3-100%调光（4%精度，直流输出）

- 压差反馈
  - 采样调整管压降并反馈到恒压级
  - 调节恒压级输出使得调整管压降尽可能小
  - 减少损耗，提高效率

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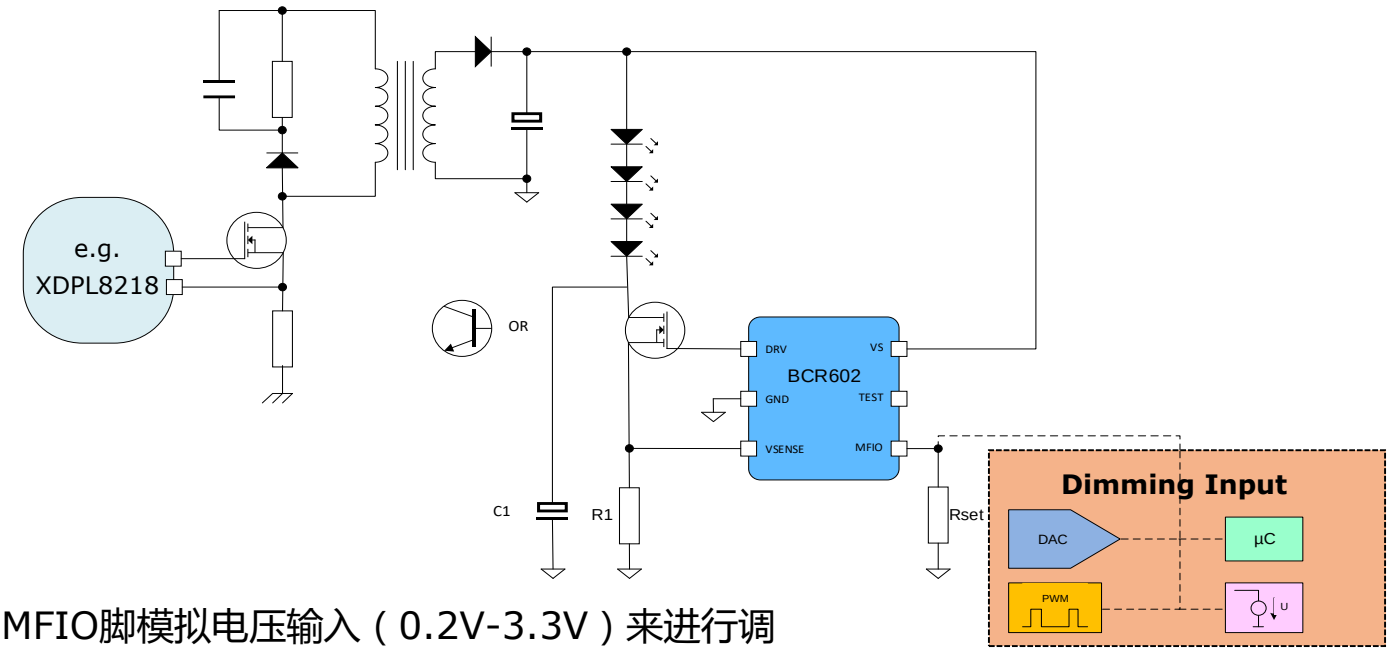
BCR602:宽调光范围，无工频纹波，热插拔保护

目标应用: LED模组



- MFIO脚模拟电压输入（0.2V-3.3V）来进行调光，此时调光电流输出为直流状态，最低可达设置电流的3%。
- PWM信号输入时可达到1%的调光水平
- MFIO脚最大输入PWM频率为3.5KHz

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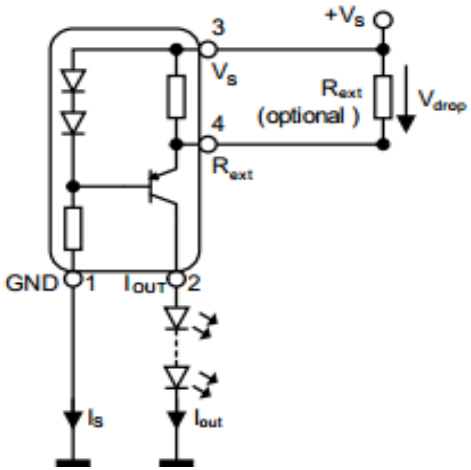
BCR系列，高精度的LED灯带驱动方案

BCR系列线性DC/DC控制器

- 适用于各种应用的LED灯带
- 电流精度可控制在±5%以内
- 灯珠亮度一致性好
- 典型应用线路简单



景观灯带

冰箱橱柜

广告标牌

灯带灯条

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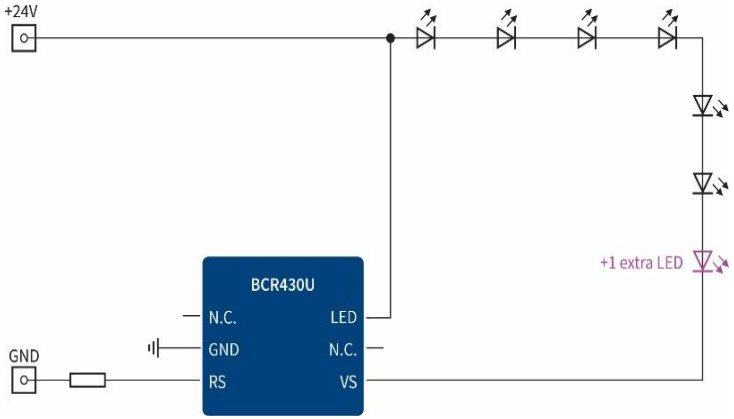
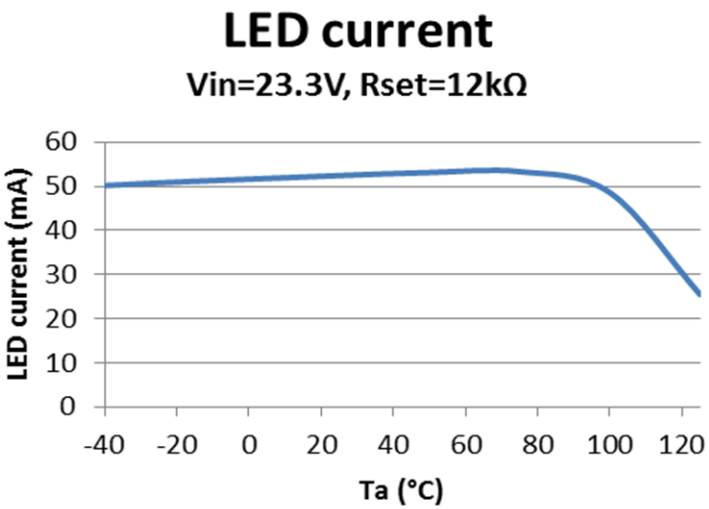
BCR430U 高光效，能带更多LED灯珠

- 低至0.135V的典型压降，远低于同类产品约1V的水平
- 每串可以多带一个灯珠，增加灯串的光效
- 智能温度保护，BCR430U温度过高时，会自动降低电流，延长寿命



以24V电压驱动3V灯珠为例：

其它驱动1V压降	BCR430U 0.135V压降
24V-10%压差=21.6V	24V-10%压差=21.6V
6个灯珠*3V=18V	6个灯珠*3V=18V
21.6V-18V-1V IC压降=2.6V	21.6V-18V-0.135V IC压降=3.6V
2.6V不足以驱动第7个LED灯珠	3.6V足以驱动第7个灯珠



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目录

- 概述
- 采用ICL5101/5102/5102HV的PFC+LCC的优化方案
- 数字控制LED驱动方案
  - XDPL8221：PFC+Flyback,限功率,极低待机，通讯功能
- DC/DC LED驱动 ILD8150/BCR60X/BCR系列
- 高效可靠的CoolMOS™ P7系列

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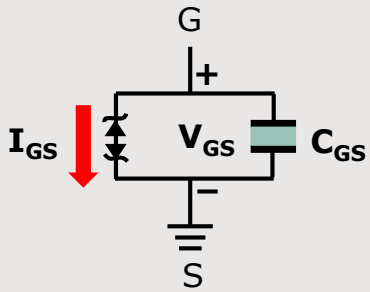
P7系列重要优点_ 1：增强的ESD保护

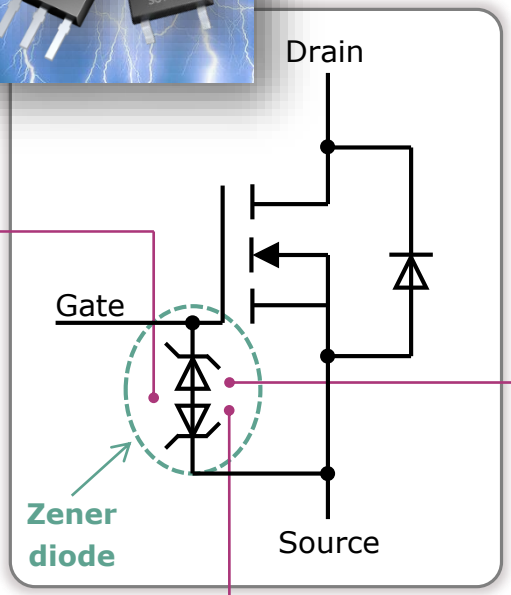
■ 集成ESD保护， 减少ESD损坏风险

ESD Protection Mechanism



ESD 发生时：

- VGS 被Zener Diode钳位
- IGS 流过Zener Diode
- 保护门极



CoolMOS™ P7 ESD Robustness

HBM:

- 0.75 – 2.00 Ω: 1–2 kV (Class 1C)
- 0.36 – 0.60 Ω: 2–4 kV (Class 2)

CDM:

- >1 kV (Class C3)

Customer Benefit

- 在MOSFET产品级增强ESD的防护能力
- 减少客户生产线上的失效
- 改善客户生产通过率和损耗

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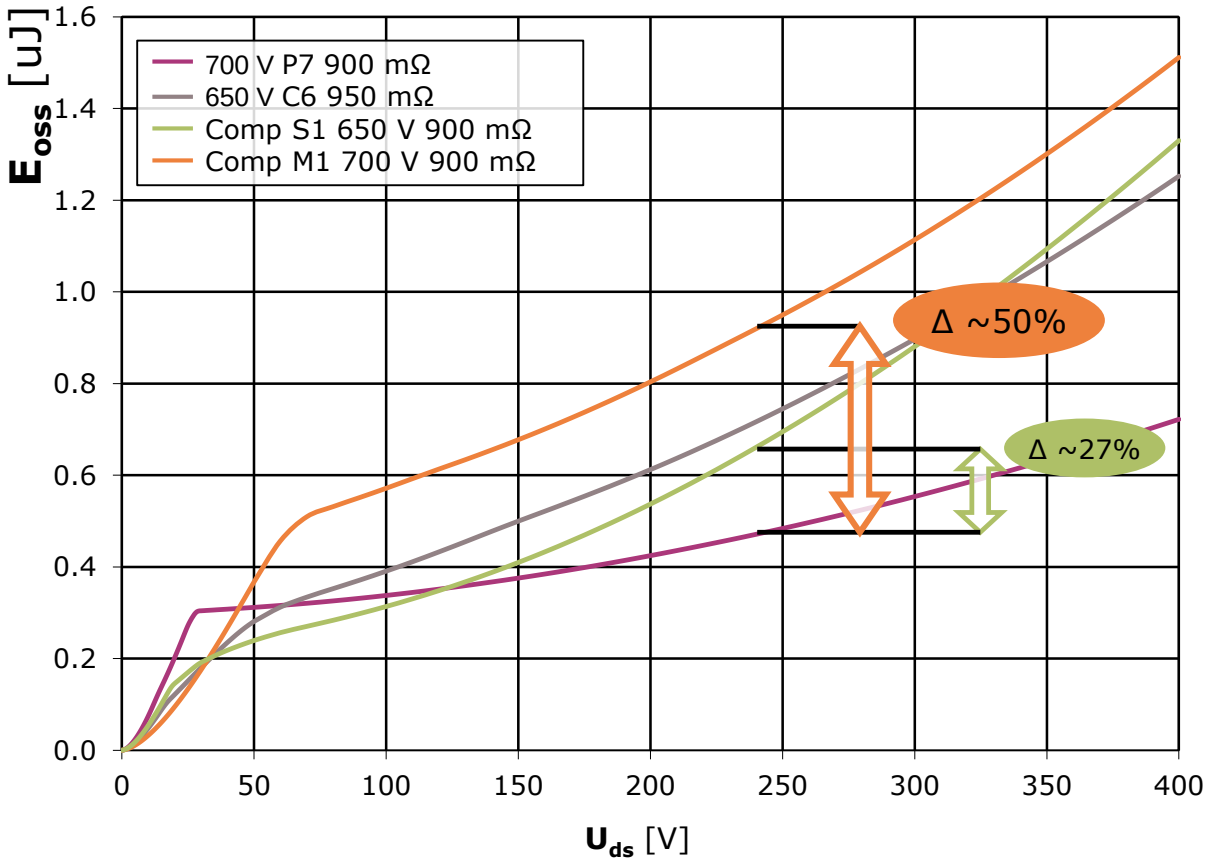
P7系列重要优点_2：进一步降低开关损耗（E_{OSS}）

开光损耗(E_{OSS})



700 V P7 shows:

- **明显降低损耗**
- 相比其它品牌，降低的损耗科大 27% ~50%
- 相比于先前的英飞凌C6系列，损耗大约降低34%

E_{oss} calculated based on C_{oss} measurement - applied at Infineon's characterization laboratory

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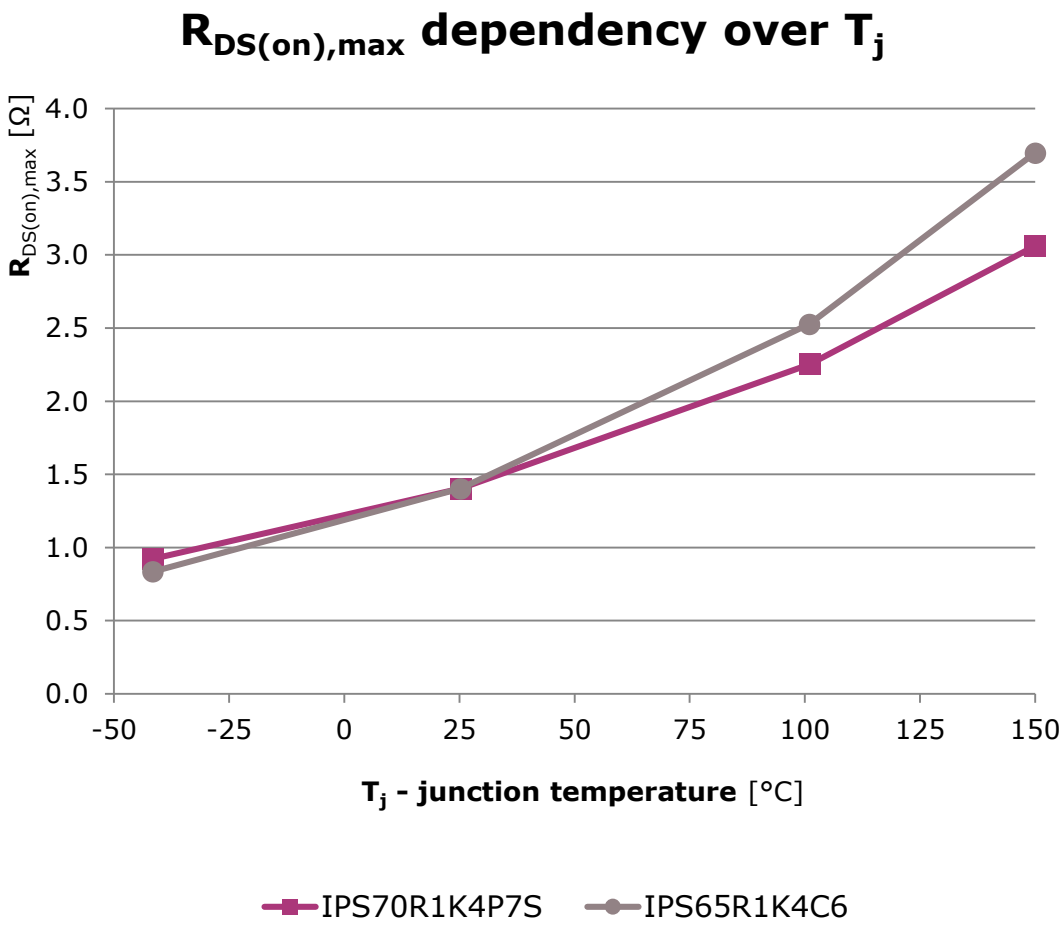
P7系列重要优点_3：减小结温Tj 对$R_{DS(on)}$的影响

$R_{DS(on)}$ v.s T_j



700 V P7 系列:

- $R_{DS(on)}$ 随结温上升比先前的 CoolMOS™ 技术更平缓
- 提高了可用功率范围
- 特别是对低输入电压更有帮助

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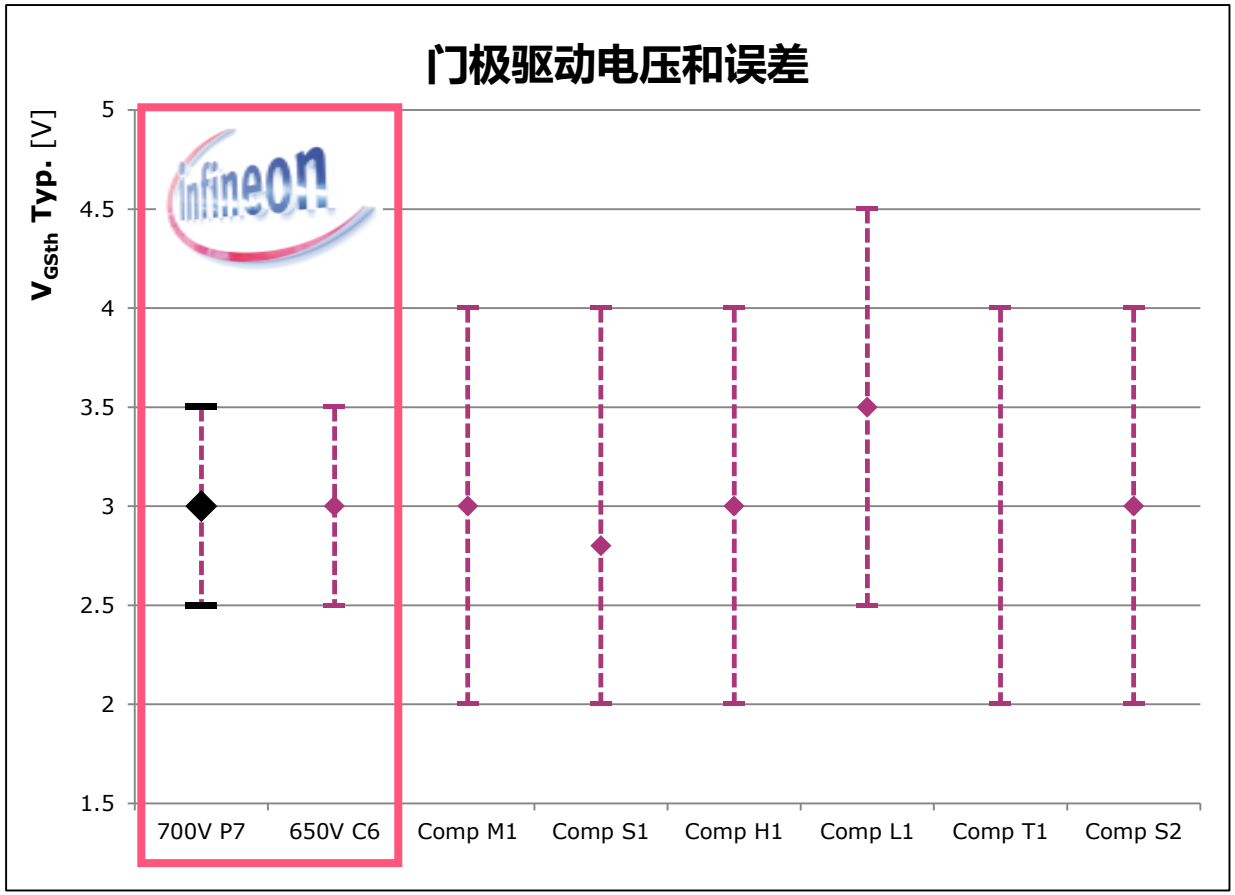
P7系列重要优点_4：较小的$V_{GS(th)}$范围，高一致性



P7系列的门极驱动电压误差范围更小

容易驱动

- 避免进入线性区
- 允许更低的驱动电压
- 减少不必要的损耗

容易设计

- 增加设计弹性

Infineon identified as only supplier offering such low threshold values

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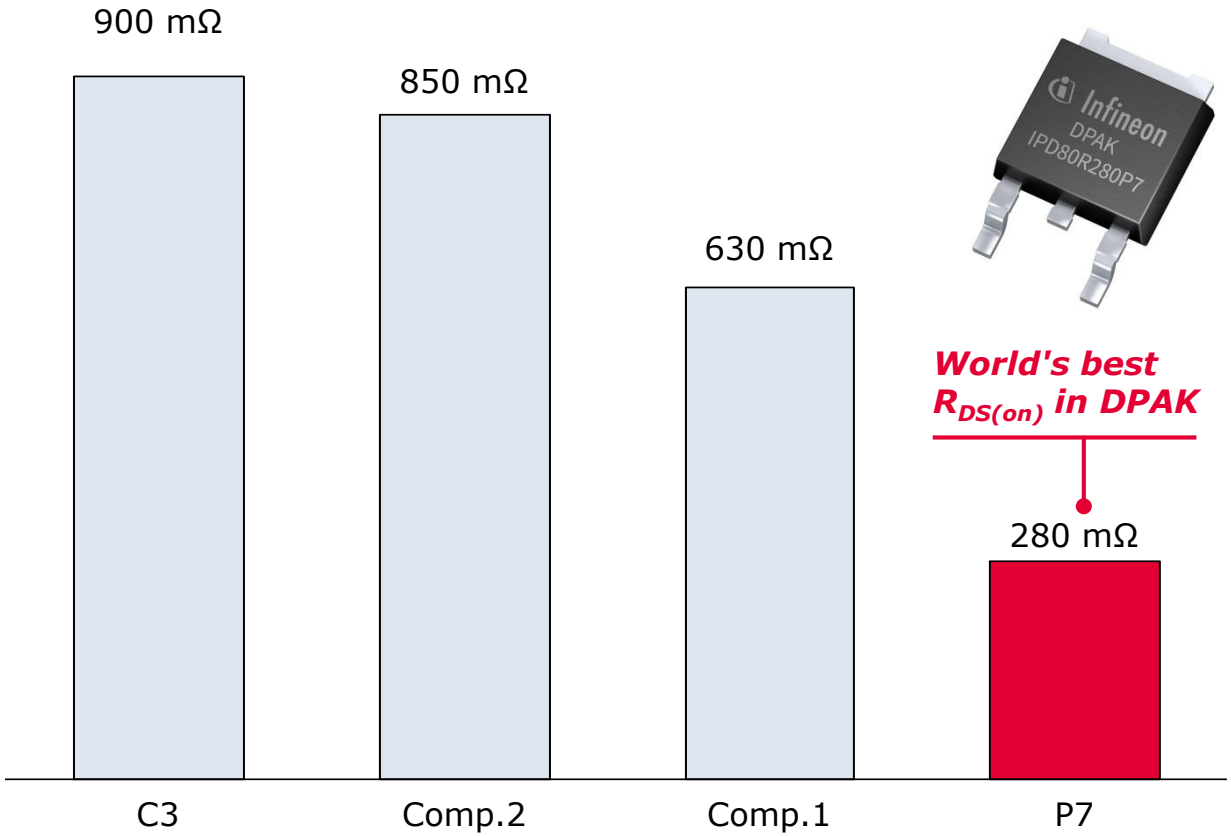
针对Lighting应用的新封装
更低的RDS(on)，可用TO-252代替TO-220F封装

- TO-252贴片封装代替TO-220F插件封装已经是趋势
- 提高可靠性，降低成本，提高生产效率
- 建议150W以及以下功率段，均可考虑采用TO-252贴片封装。



- **业界最好DPAK $R_{DS(on)}$**

好处:

- **高功率密度**
- **低总成本**
- **降低生产成本**

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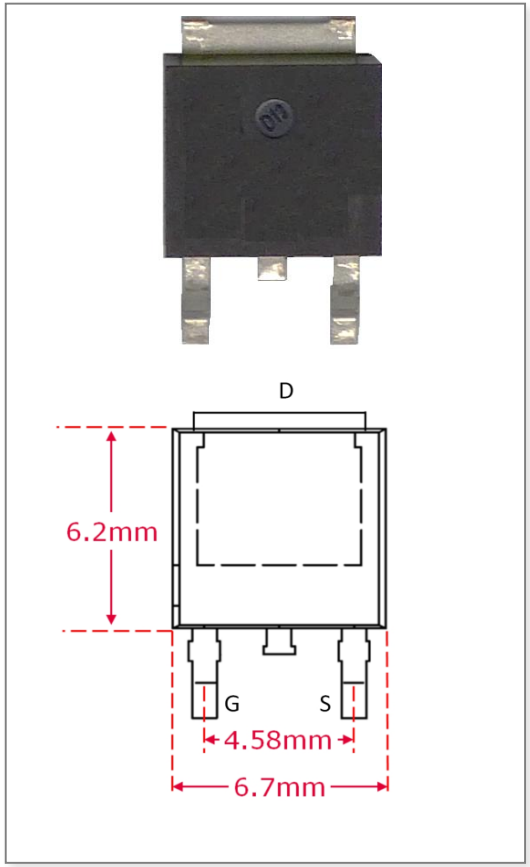
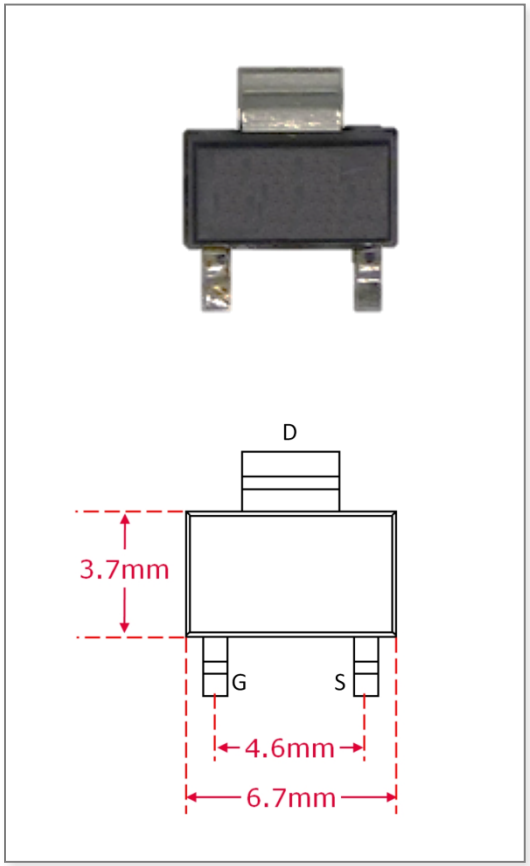
针对Lighting应用的新封装
SOT-223 系列CoolMOS™，小型化设计首选

TO-252



SOT-223



- <40W的小功率设计，可以采用更小的SOT-223封装。

- 好处
  - 比TO-251更高的生产效率
  - 比TO-252更小的占板面积
  - 比TO-252更低的封装成本

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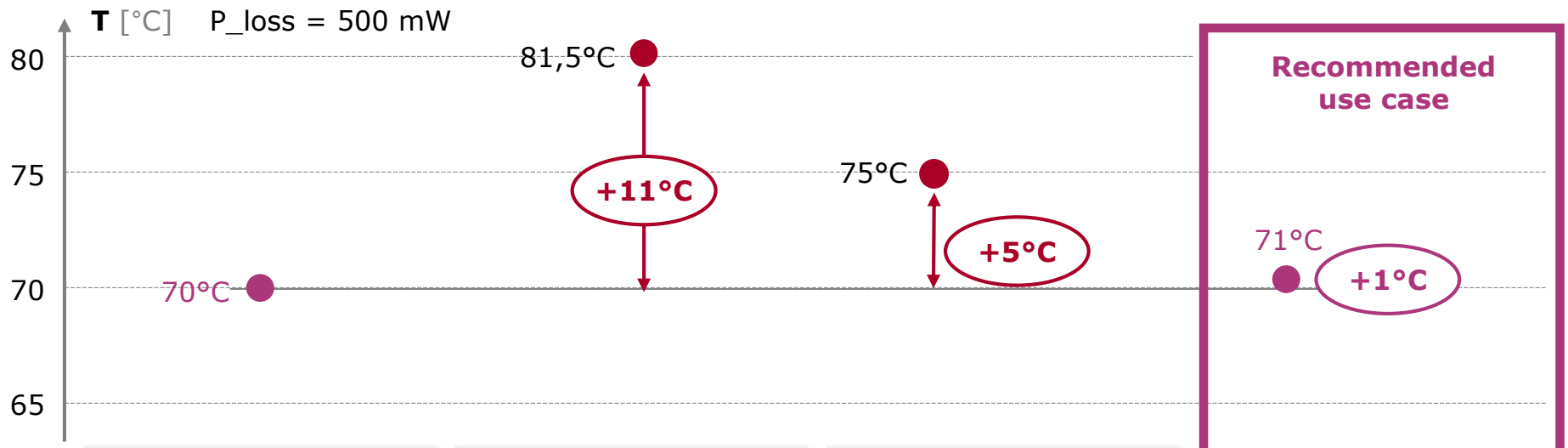
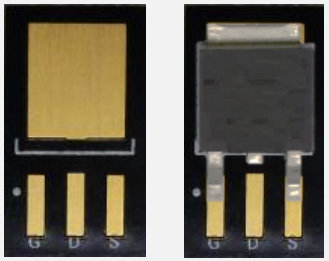
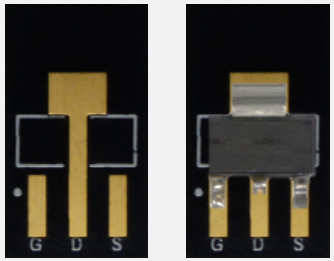
SOT-223替代DPAK是可行的



DPAK on DPAK footprint (reference)
=40mm² Cu

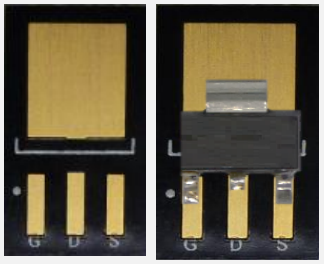


SOT-223 on SOT-223 footprint
=8mm² Cu



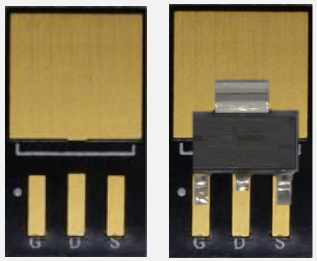
- Good for **low power levels**
- Footprint savings vs DPAK

SOT-223 on DPAK footprint
=40mm² Cu



- Drop-in replacement for DPAK
- Good for **designs with thermal margin**

SOT-223 on DPAK footprint + 20mm²
=60mm² Cu



- Replacement for DPAK
- Good for **designs with sufficient cooling area**

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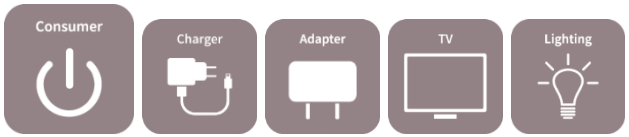
CoolMOS™ P7 SOT-223 产品列表

Portfolio CoolMOS™ P7 in SOT-223			
$R_{DS(on)}$ [mΩ]	Standard grade		Industrial grade
	600 V	700 V	800 V
4500			IPN80R4K5P7
3300			IPN80R3K3P7
2400			IPN80R2K4P7
2000		IPN70R2K0P7S	IPN80R2K0P7
1400		IPN70R1K4P7S	IPN80R1K4P7
1200		IPN70R1K2P7S	IPN80R1K2P7
900		IPN70R900P7S	IPN80R900P7
750		IPN70R750P7S	IPN80R750P7
600	IPN60R600P7S	IPN70R600P7S	IPN80R600P7
450		IPN70R450P7S	
360	IPN60R360P7S	IPN70R360P7S	



In production

Coming soon

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结论

- ICL5101/5102/5102HV集成PFC和半桥谐振驱动有利于减少零件数目
- 采用PFC+LCC拓扑方便实现恒流状态下**宽范围**的电压输出，有利于精简平台
- 采用数字化驱动IC有利于简化设计，提高性能，减少库存，快速推向市场，易于实现智能照明
- BCR60x/ILD8150系列拓宽了英飞凌DC/DC LED驱动芯片业务范围
- 采用英飞凌的 CoolMOS™ 有利于效率的进一步提高，P7系列具有更好的性能，更高的性价比
- 其中SOT223的小封装优势有利于小型化，并进一步优化成本结构

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2019-02-19

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