

# ADI High Performance Power Solutions

Harrison Zhang(章浩)

Principle MTS, CDE BU

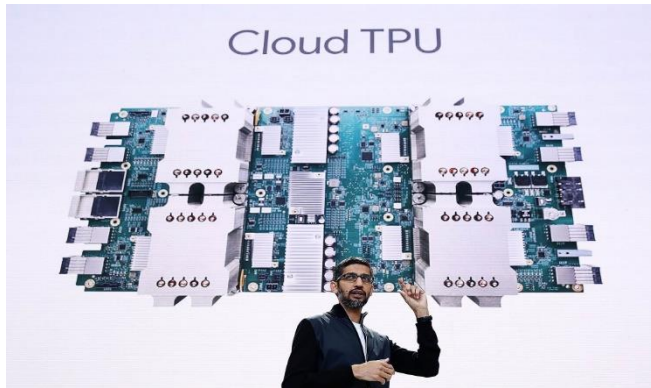
# Agneda

- 1.面向AI, Server应用的高功率电源解决方案
- 2.面向5G应用的高功率电源解决方案
- 3.Power over Ethernet(PoE) 产品及应用技术



# 1.面向AI, Server应用的高功率电源解决方案

# AI, Server应用电源需求背景介绍



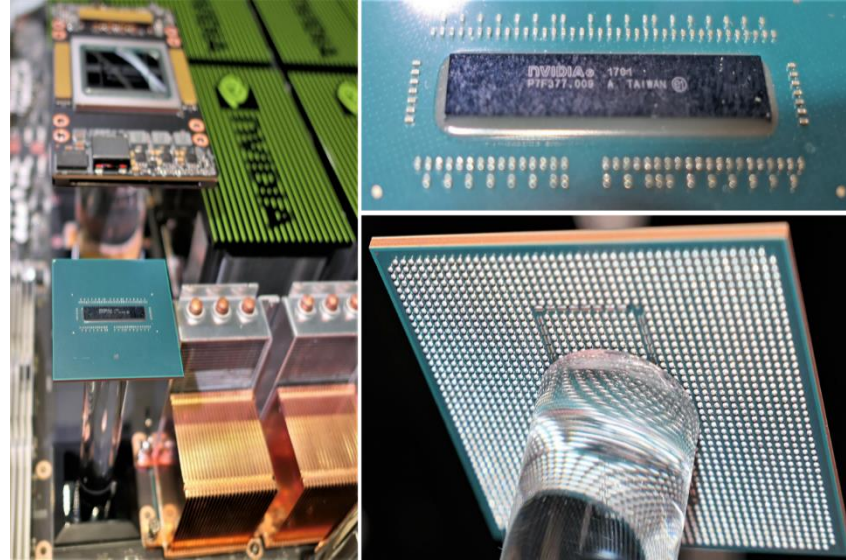
Component	Today	Next Gen	Future
<b>CPU</b>	200W	300W	400W
<b>Memory</b>	70W	90W	120W
<b>GPU</b>	300W	400W	500W
<b>FPGA</b>	60W	100W	125W

随着功率需求的不断提升，48V总线电压也越来越成为一种趋势。

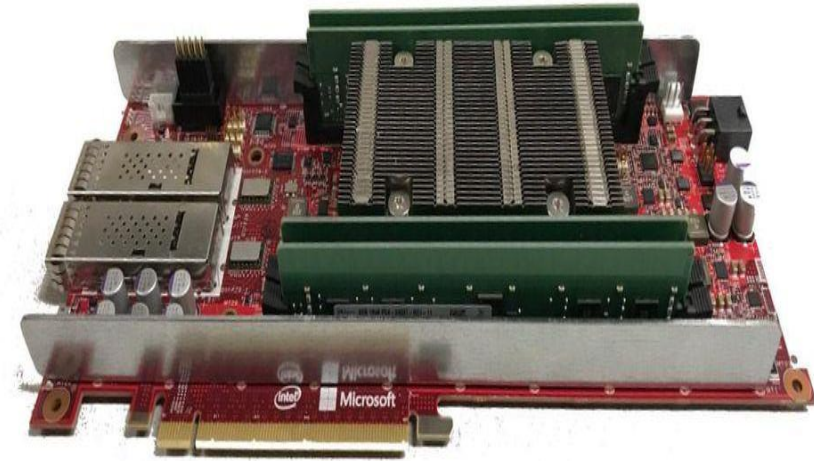
# ADI能为各种不同的应用做定制化的方案



CPU's



GPU's



FPGA/ASICs

# ADI独特的三大技术优势

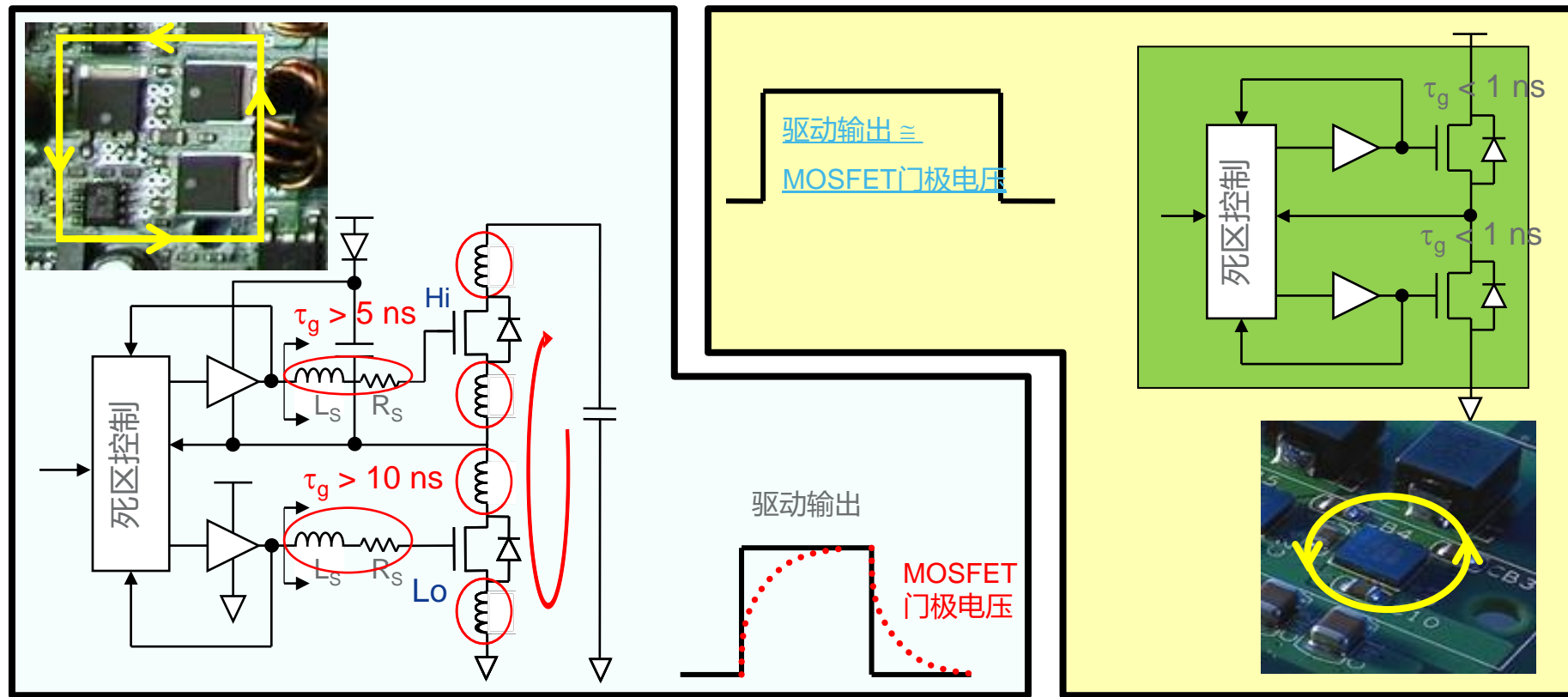
	<h2>单Die工艺 高集成度</h2>		<h2>QFN封装</h2>		<h2>耦合电感技术</h2>
<ul style="list-style-type: none"><li>• 高效率, 高功率密度</li><li>• 集成高精度的采样电路 (电流, 电压, 温度...)</li></ul>		<ul style="list-style-type: none"><li>• <math>\Theta_{JC} &lt; 1^{\circ}\text{C}/\text{W}</math></li><li>• 双面散热</li></ul>		<ul style="list-style-type: none"><li>• 专利技术</li><li>• 引领业内瞬态响应性能</li></ul>	

特有技术优势和整体解决方案, 满足了未来对功率, 功率密度及性能不断提高的需求。

# 技术优势 (1) :

## —单Die工艺, 高集成度

几乎消除了功率器件间的寄生参数, 实现了高效率及小型化。



离散功率器件

ADI高集成度的功率器件

## 技术优势 (2) :

### —双面散热的QFN 封装技术

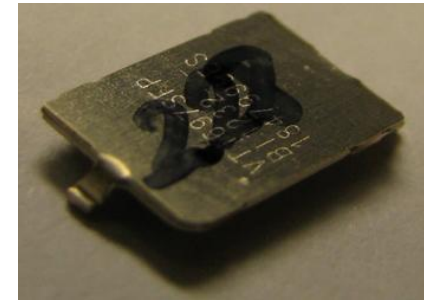
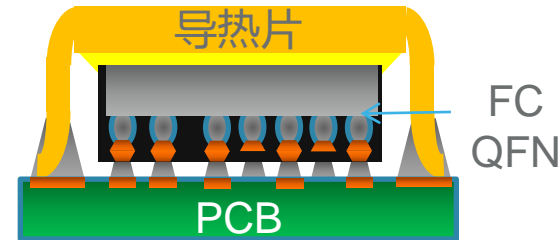
#### 标准的QFN封装

- 芯片底部的铜条引脚紧贴PCB散热
- 周边注塑保护die
- 表面裸die更利于散热



#### 加装导热片的QFN

- 集成导热片
- 导热片接触PCB提供第2条散热路径
- 减小16%~24%的热阻 ( $\Theta_{JA}$ )



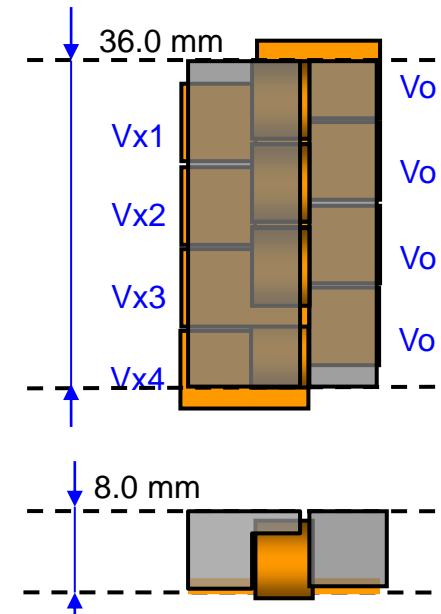
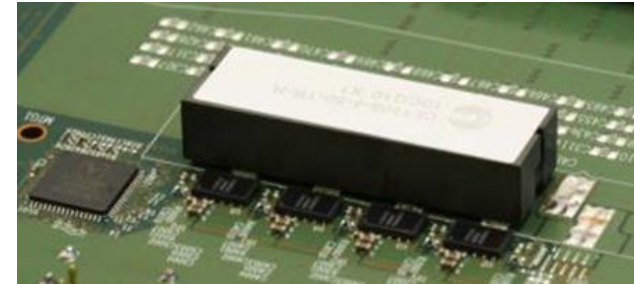
裸die及加装导热片的QFN封装技术提供了最小的热阻 ( $\Theta_{jc}$ ) , 可以做到前所未有的功率密度



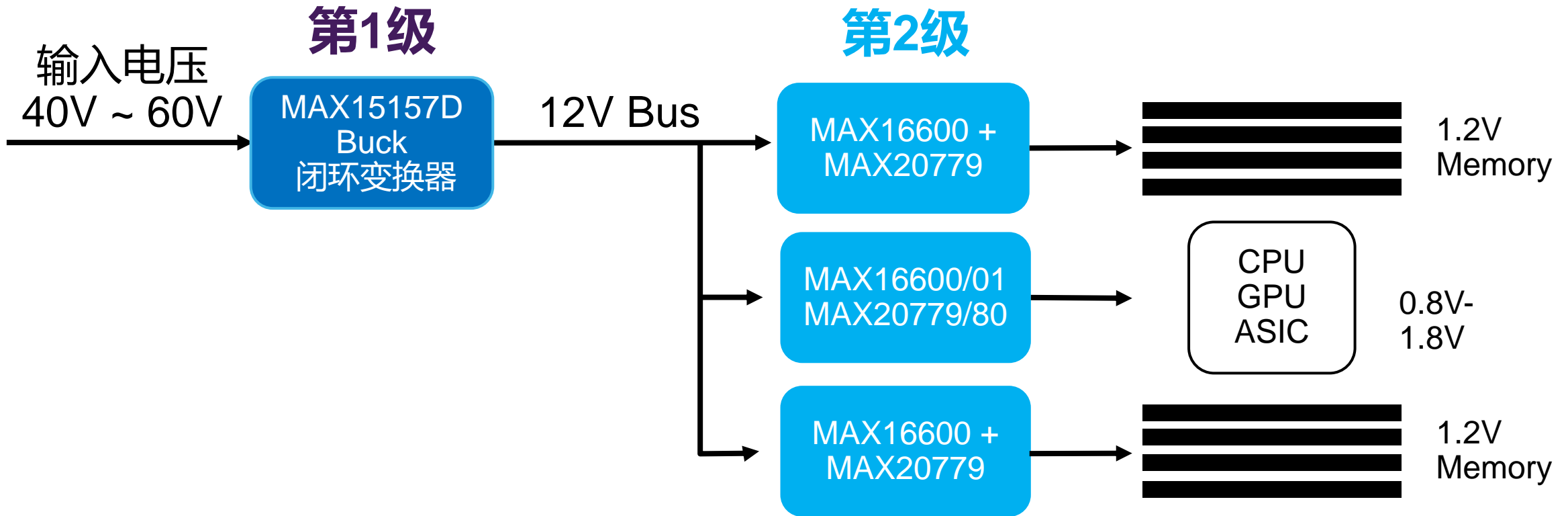
# 技术优势 (3)

## —耦合电感

- 耦合电感实质相互独立的绕阻共享同一磁芯
- 大大减小每相的电感量(100nH,50nH)
  - > **大大提升瞬态响应性能**
  - > **全瓷片电容设计, 减少电容数量**
- 提升电源系统的效率
- 可以满足各种不同需求的应用场景 – 性能,高度, 尺寸及成本
- 众多的供应商(Pulse, Eaton, Sunlord, Mag layer...)



# ADI 48V 两级电源方案架构



第2级高效率、高集成度的电源方案可以很好的支持CPU、GPU、ASIC和Memory等应用。

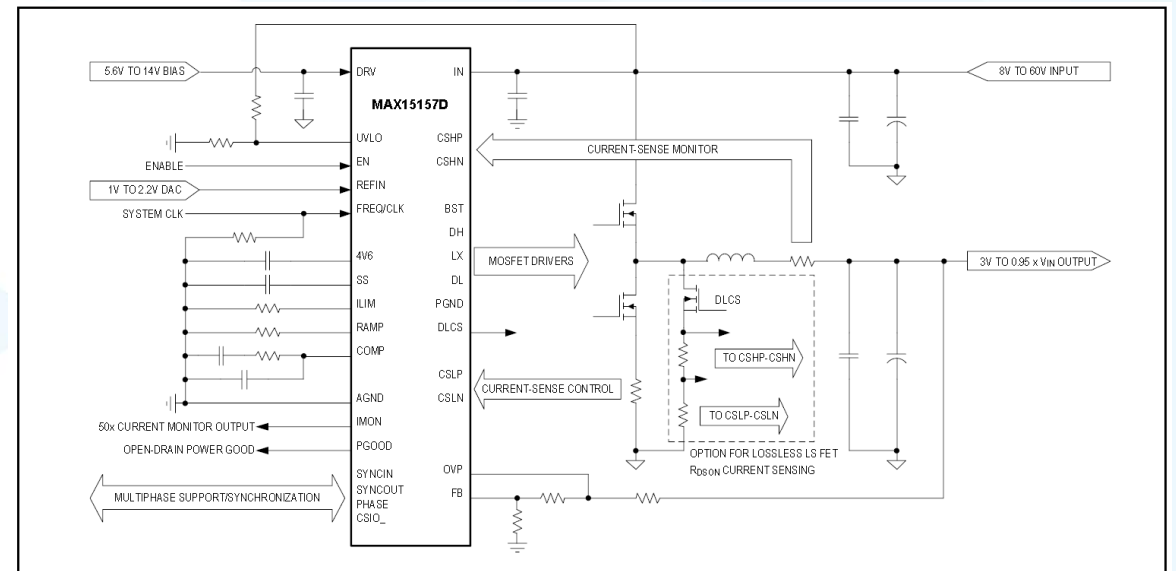
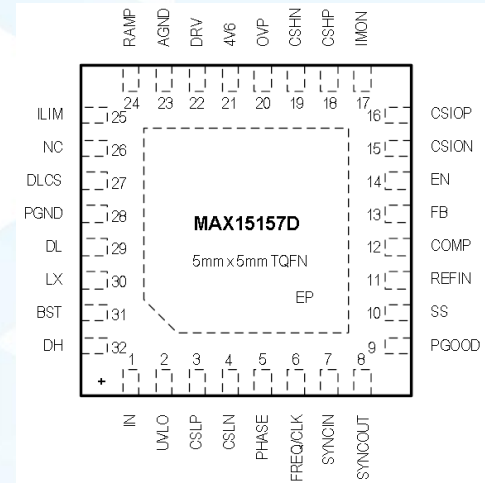
# 60V降压控制器介绍—MAX15157D

## 主要优点

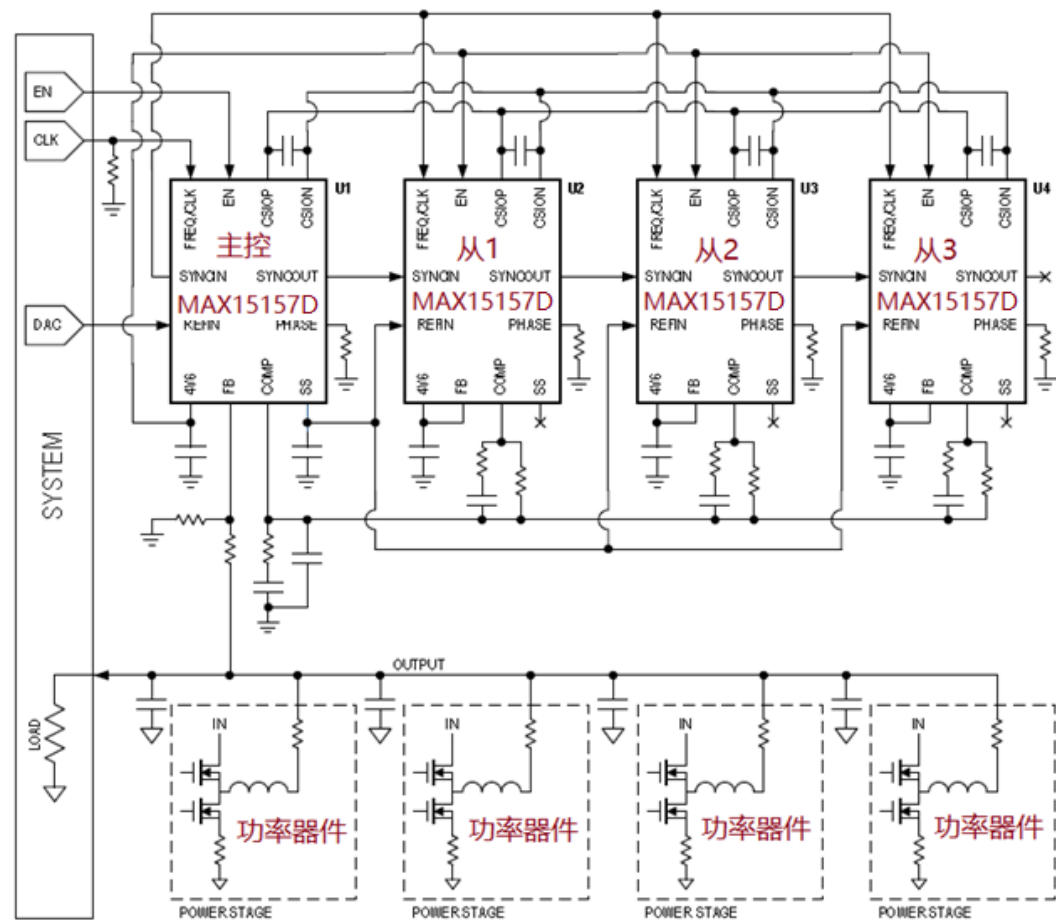
- 可支持8相并联
- 集成了均流控制电路
- 内置了高压Mosfet驱动器
- 集成了非常可靠的错误保护功能，以提高产品质量及简化系统设计，如过流/短路，过压，欠压及过温保护等

## 主要功能

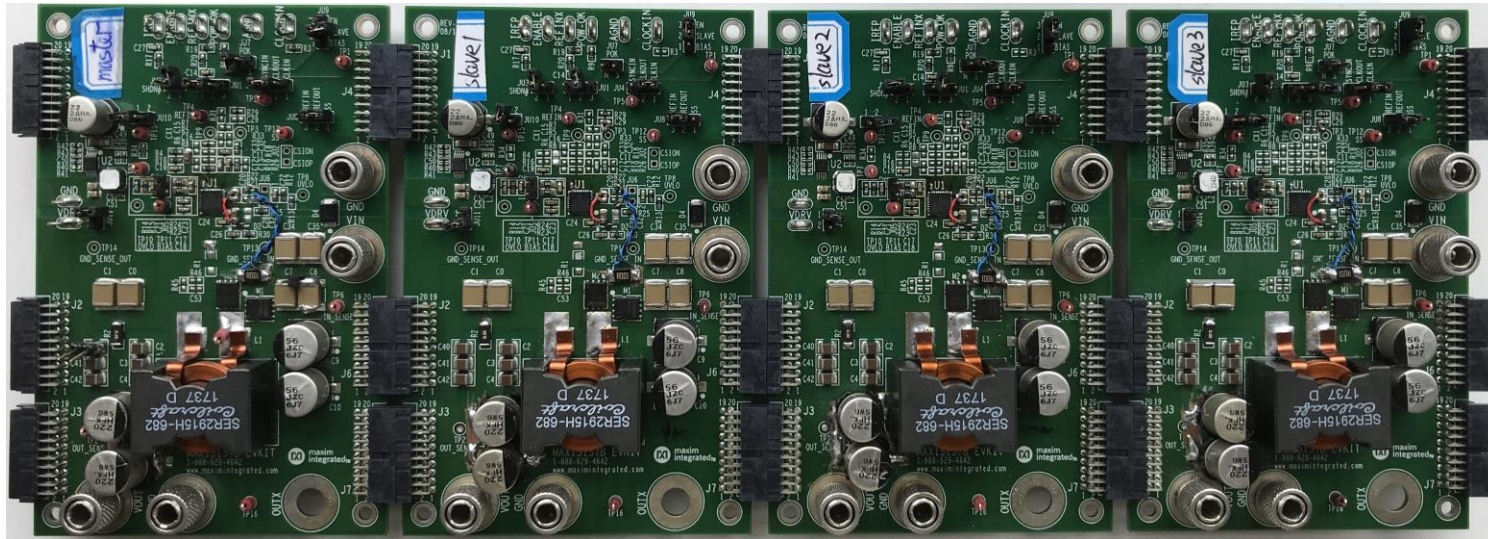
- 输入电压范围: 8V 到 60V
- 输出电压范围: 3V 到  $0.95 \times V_{in}$
- 开关频率范围: 60kHz to 1MHz
- 集成了电流上报功能(Imon)
- 集成了偏置电源的LDO
- 集成了可调节的斜坡补偿功能
- 开关频率支持外部时钟同步
- 过压，欠压，过流等保护
- 工作温度范围:  $-40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$
- 封装: 32-pin, 5mm x 5mm QFN



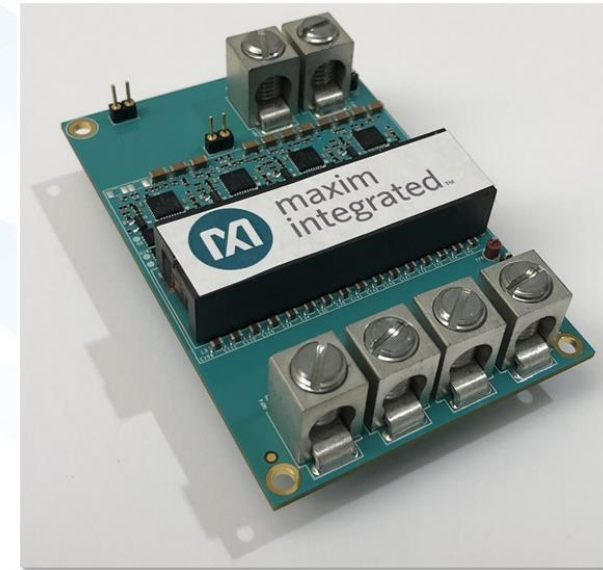
# MAX15157D 4相并联使用



# 48转12V/1200W方案 - MAX15157D

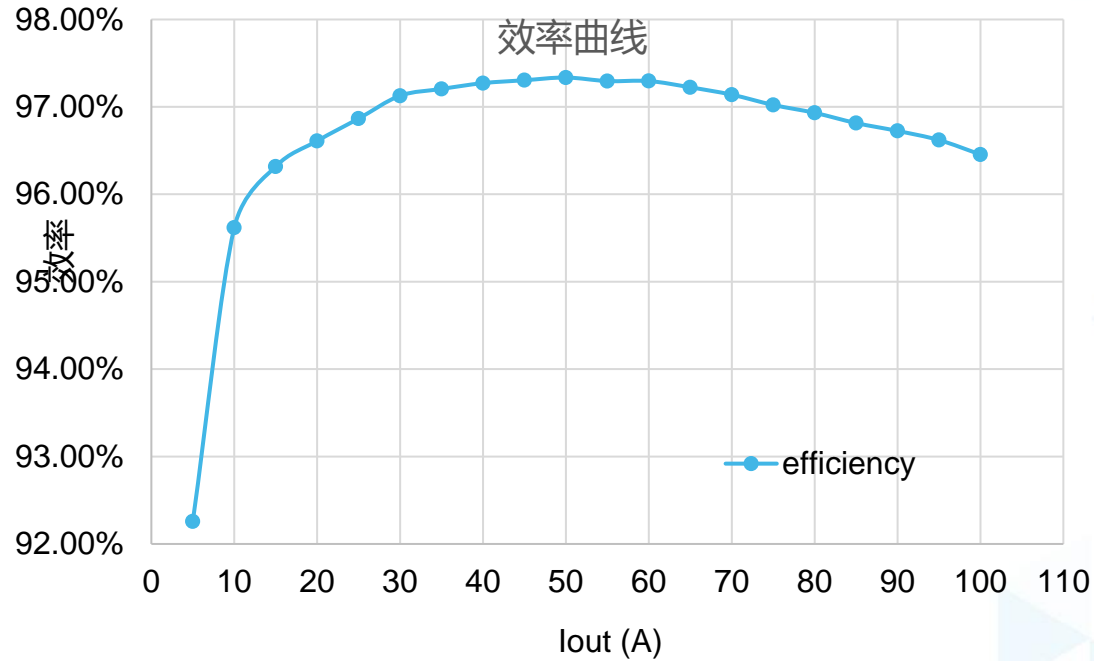


分离电感方案



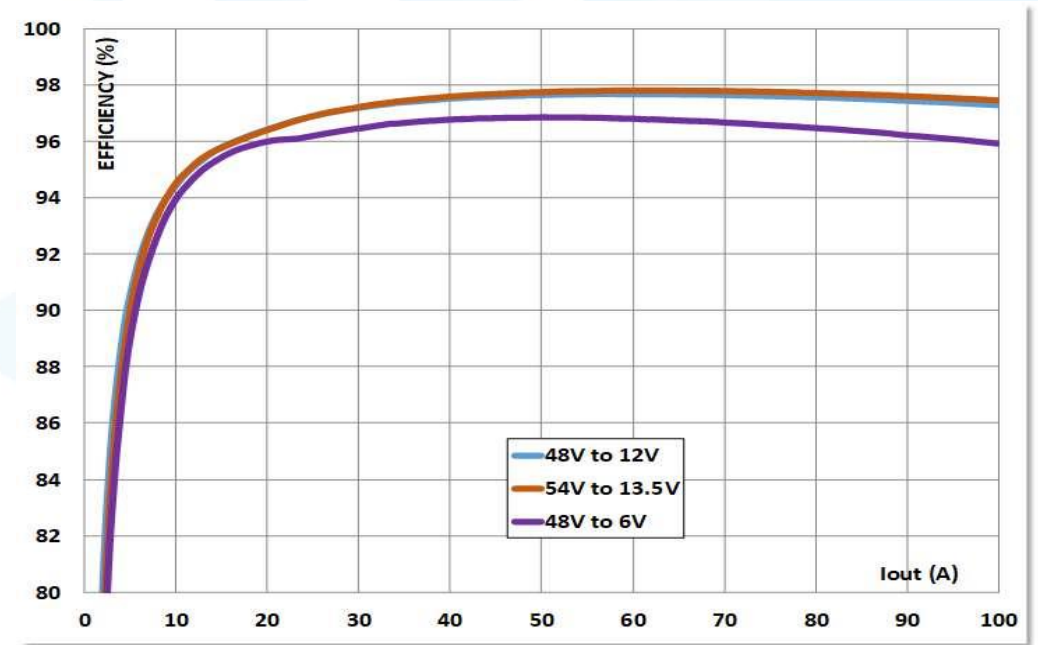
耦合电感方案

# 48V输入12V输出效率曲线



分离电感:

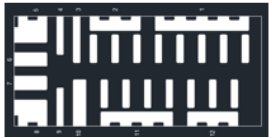
峰值效率: 97.34%; 满载时效率为: 96.46%



耦合电感:

峰值效率: 97.8%; 满载时效率为: 97.4%

# ADI第2级多相大电流方案优点



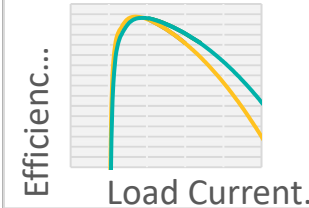
采用最新90纳米  
工艺的功率器件

- 90纳米工艺, 使得效率最优化
- 每相120A 过流保护点



新一代的耦合电  
感

- 每相140A饱和电流点
- 可以从2相扩展到6相



效率最优化

- 95.7% 的峰值效率
- 比竞争者产品效率高出+1.0%。

ADI 最新一代的功率器件和耦合电感配合使用, 可以同时实现尺寸最小化和效率最优.

# MAX16600 – 灵活的, 双路输出多相电源控制器

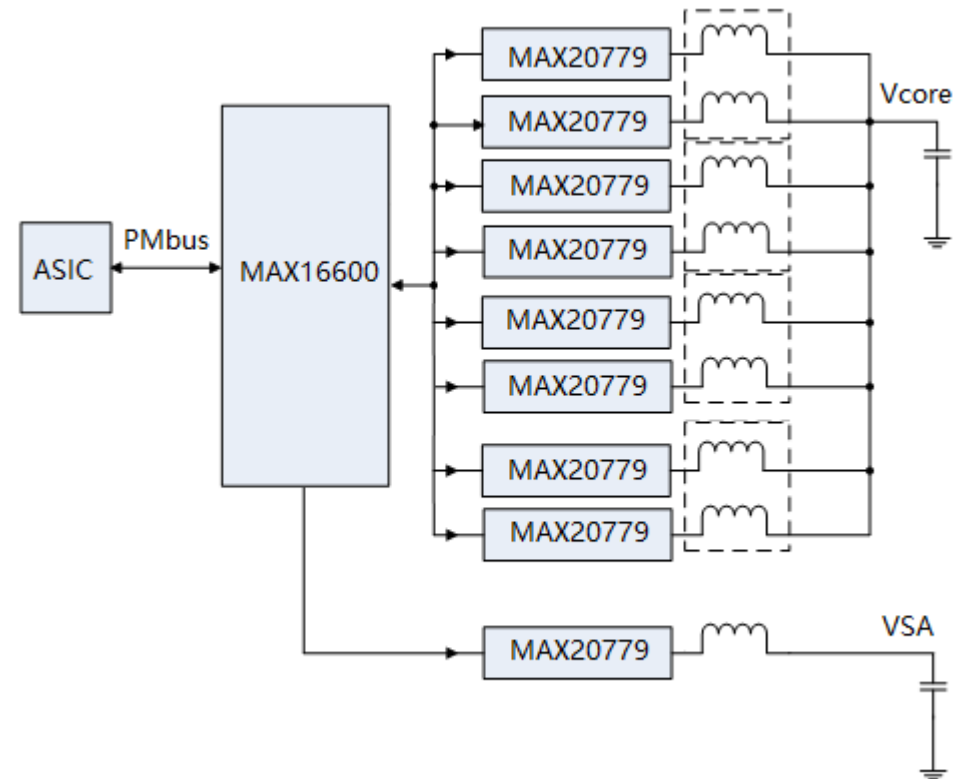
## 主要优点

- 灵活的可扩展性可以支持更大电流和更高功率密度的应用需求
- 兼容耦电感设计, 具有更快的负载动态响应能力, 可以使用更少的输出电容以节省成本
- 全面的保护功能, 过流, 过压, 欠压, 过温等保护功能

## 主要功能

- 双路独立的控制
- 可支持到 16相
- 兼容PMBus1.3 协议
- 16个一次性编程内存, 可以存储用户的配置
- 内置1.8V开关电源, 为Power Stage提供驱动电源
- 每相的工作频率可以设置在300kHz-800kHz
- 输出电压范围: 0.6V to 5.5V
- 电流平衡和电流监控功能
- 热保护及温度监控
- 封装: 48个引脚, 7mm x 7mm TQFN

MAX16600架构图





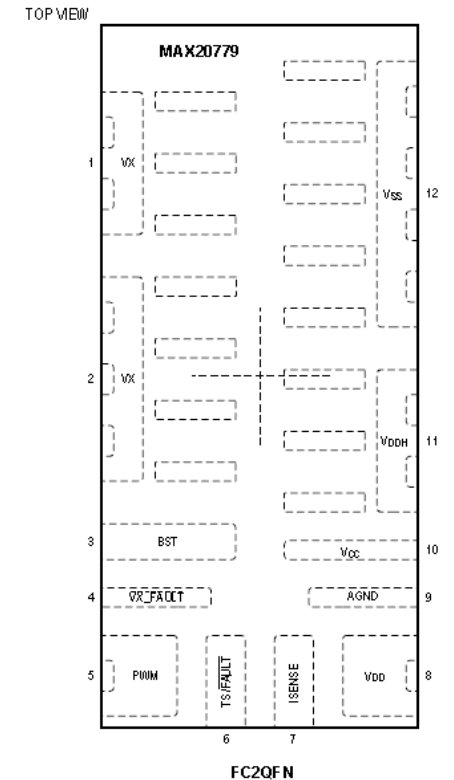
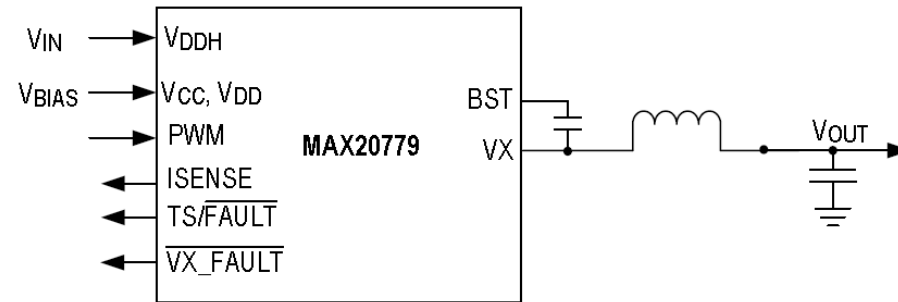
# MAX20779 智能功率Mosfet

## 主要优点

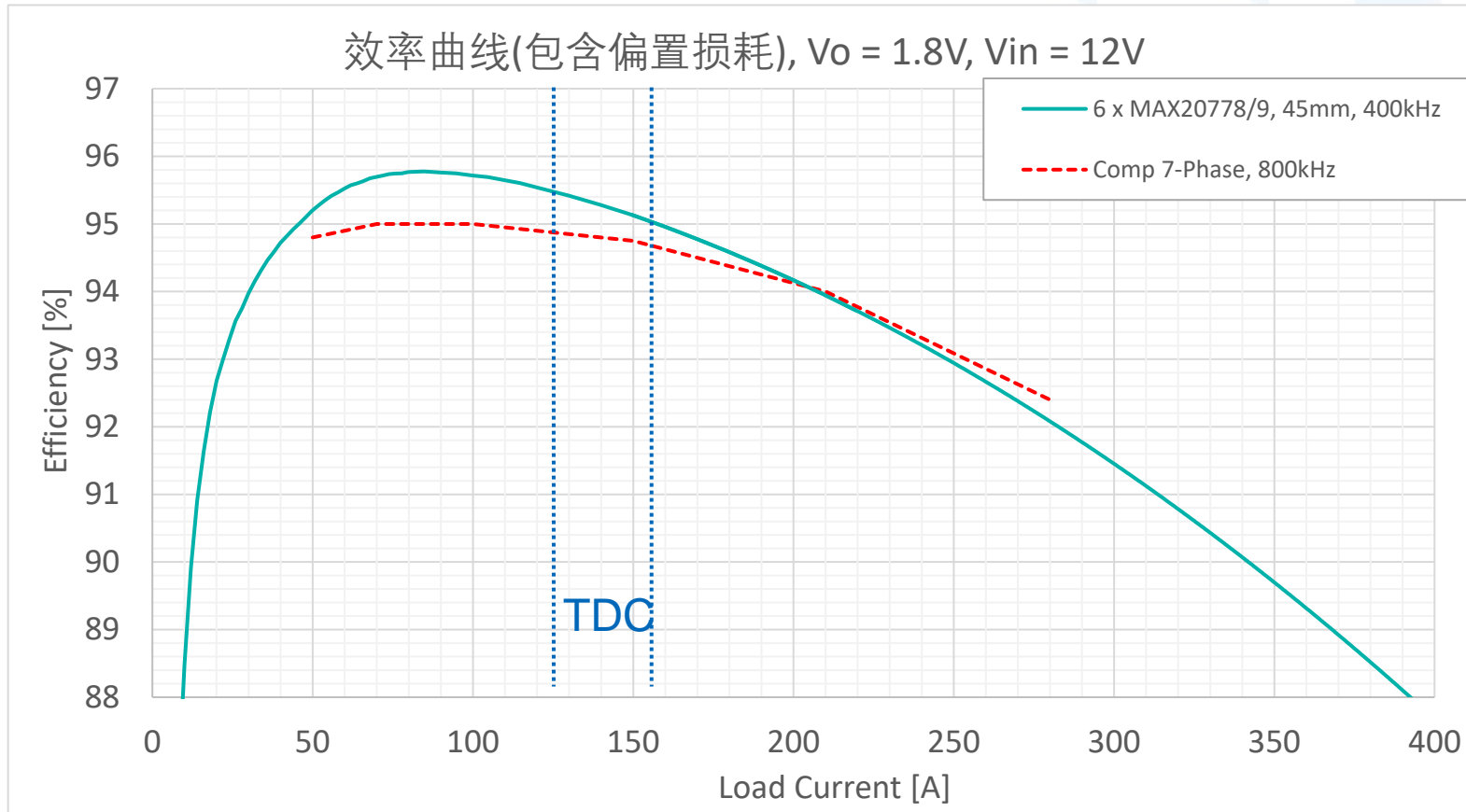
- 90纳米工艺, 更高的效率
- 双面散热的封装,  $\theta_{jc}=0.25^{\circ}\text{C/W}$
- 可支持更高电流及更高功率密度的需求
- 兼容耦电感设计, 具有更快的负载动态响应能力, 可以使用更少的输出电容以节省成本

## 主要功能

- 单高集成度芯片可最大支持120A电流
- 输入电压范围: 4.5V ~ 16V
- 集成了过流/短路, 欠压, 过热等保护功能
- 集成了电流采样功能
- 3.25mm x 7.4mm FCQFN封装



# 更少的相数实现更高的效率



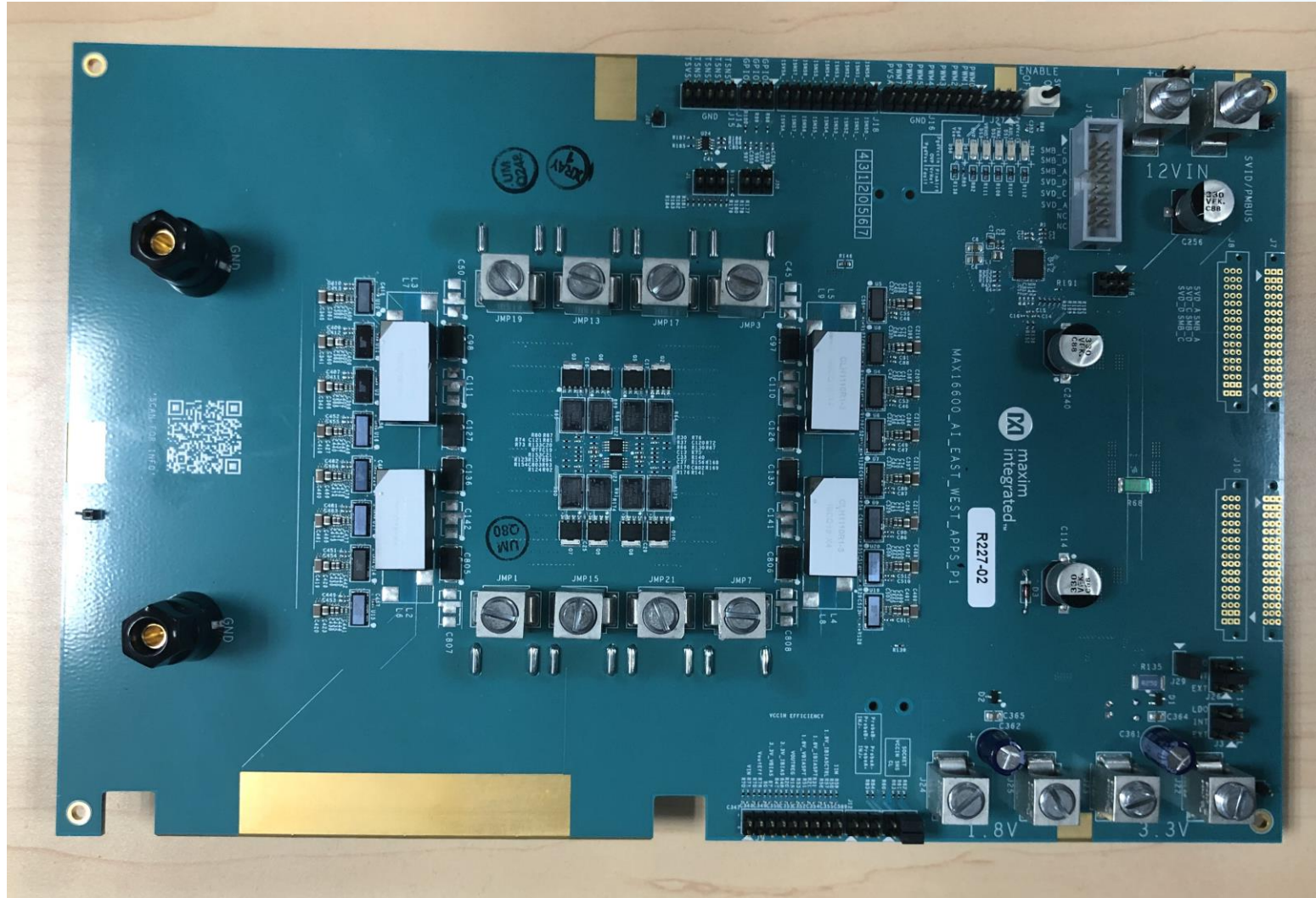
## 对比分析

- ADI: 6xMAX20779 @ 400kHz
- 竞争对手: 7相 @ 800kHz

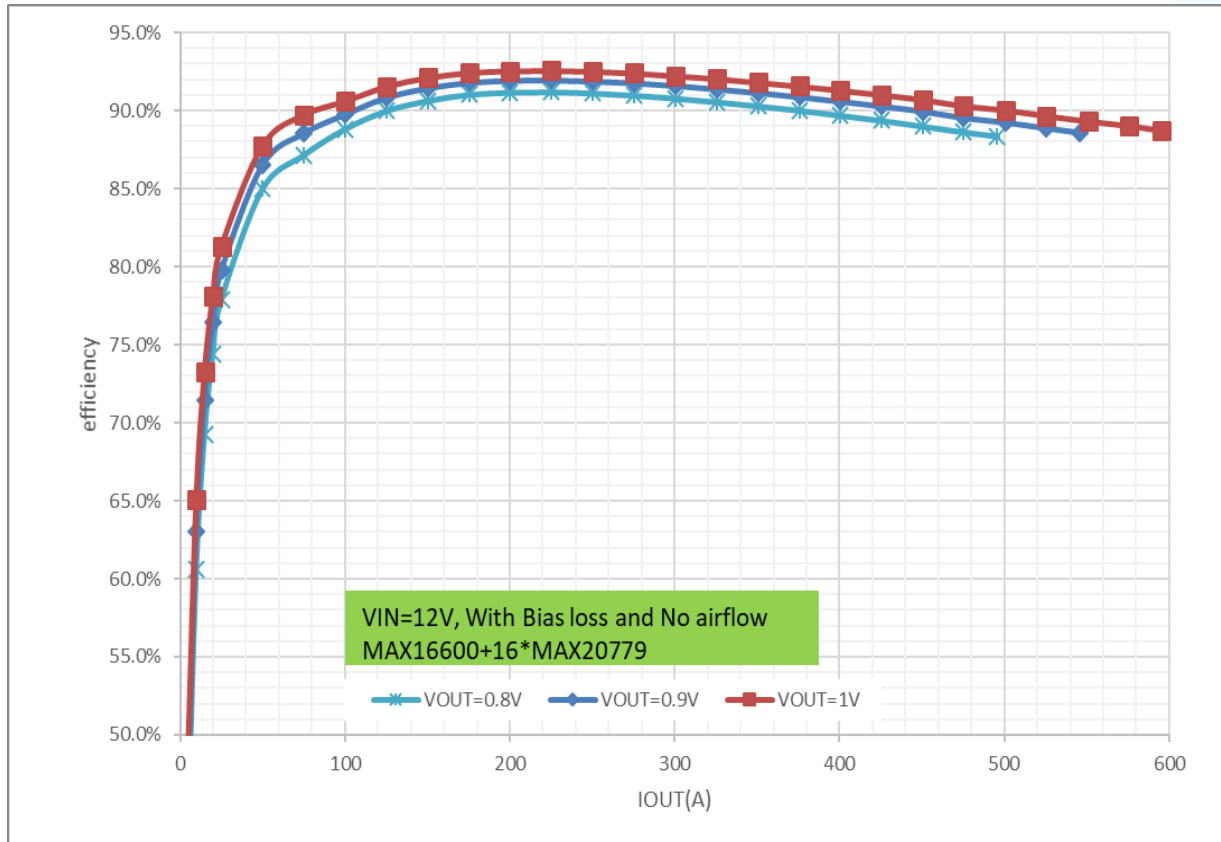
▶ 在TDC负载点, 我们的效率比竞争对手高出了0.5%-1%

**ADI方案具有更小的体积同时高出0.7% 的效率。**

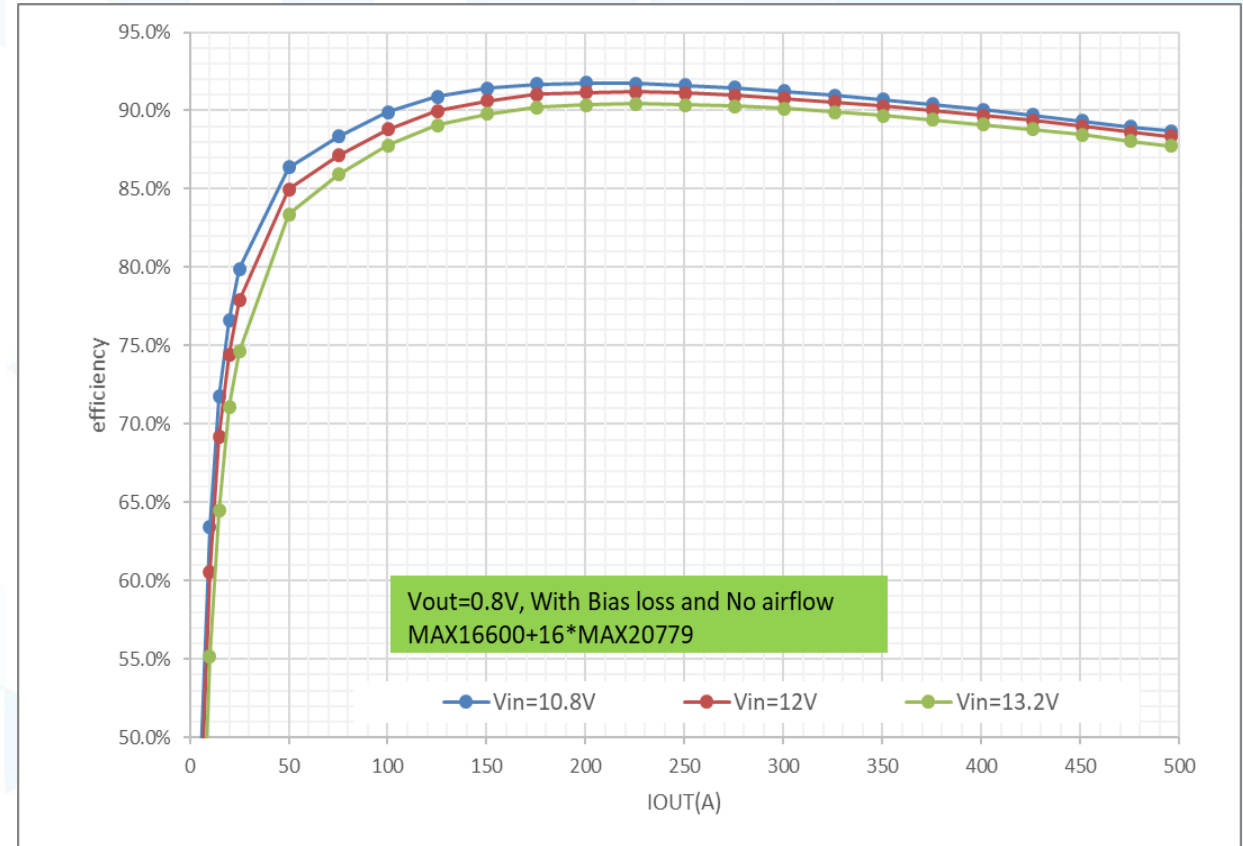
# 16相电源方案板子 - MAX16600+ 16pcs MAX20779



# 16相电源效率

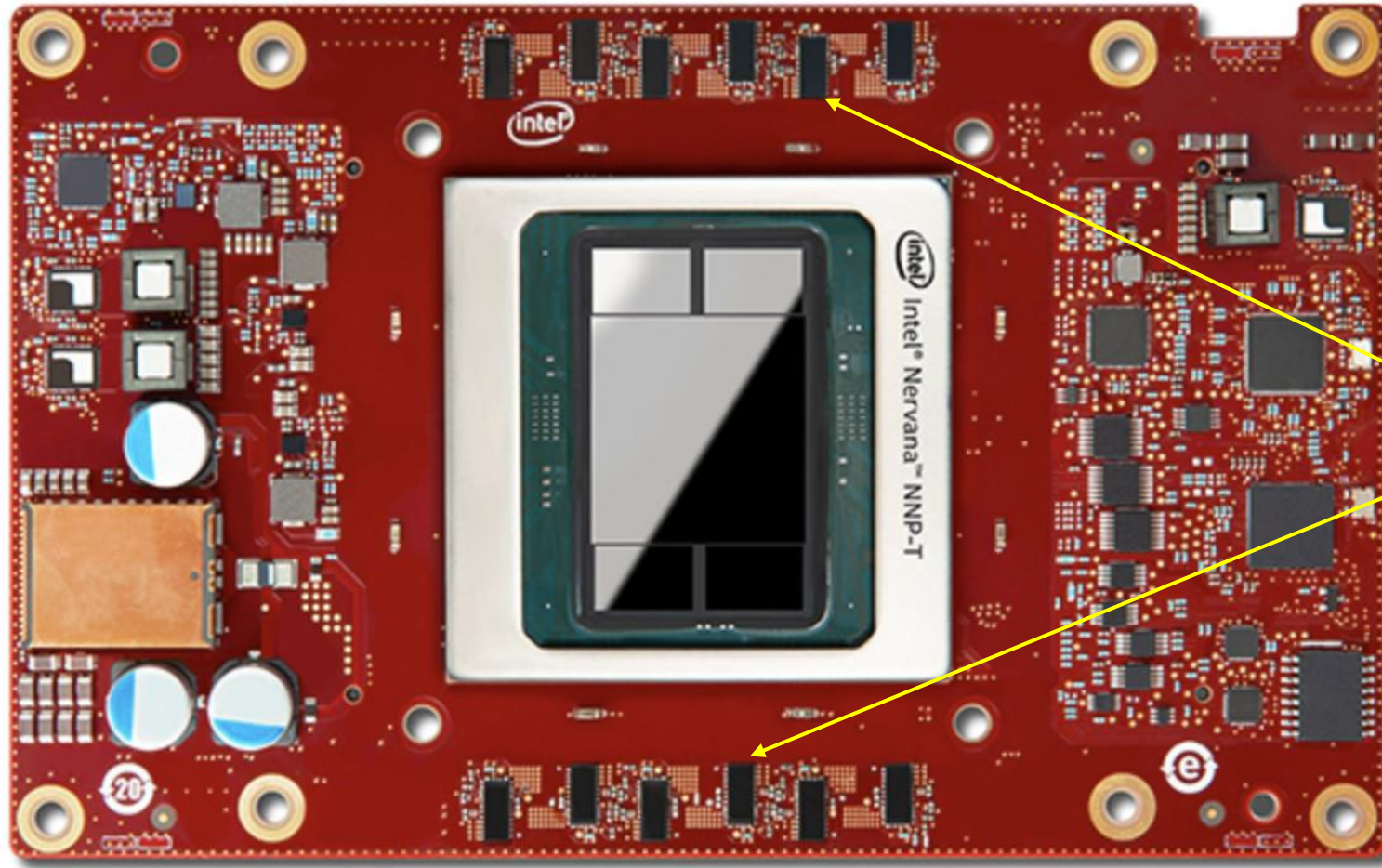


Vin=12V, Vout=0.8V/0.9V.1.0V



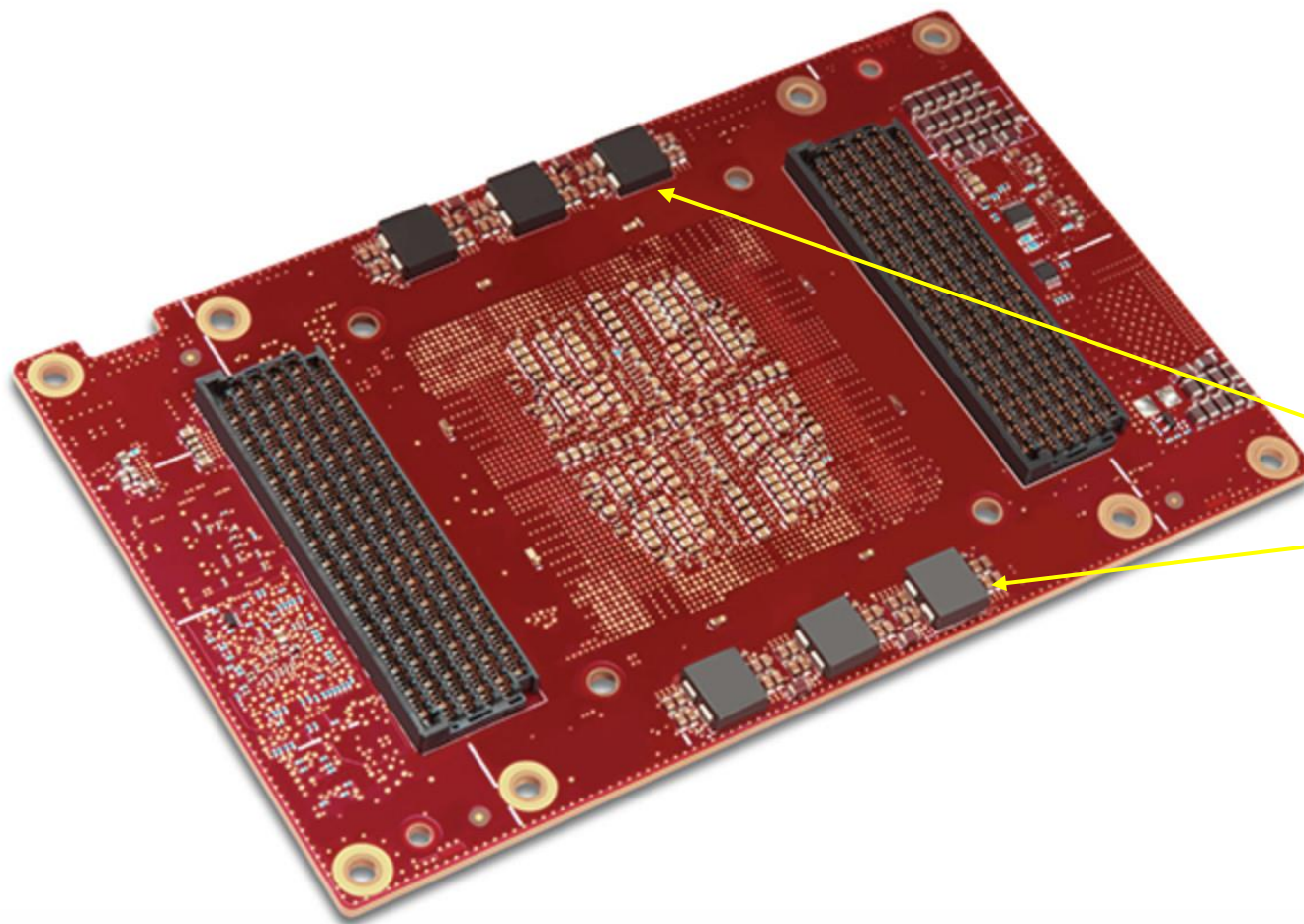
Vout=0.8V, Vin=10.8V/12V/13.2V

# 英特尔新一代VPU采用Legacy MAXIM方案



美信12相设计，  
最新90纳米智能Mos。

# 英特尔新一代VPU采用Legacy MAXIM方案



美信12相设计，  
最新的两相耦合电感。

# 百度昆仑云服务器

8相设计,  
最新90纳米智能Mos,  
最新耦合电感。

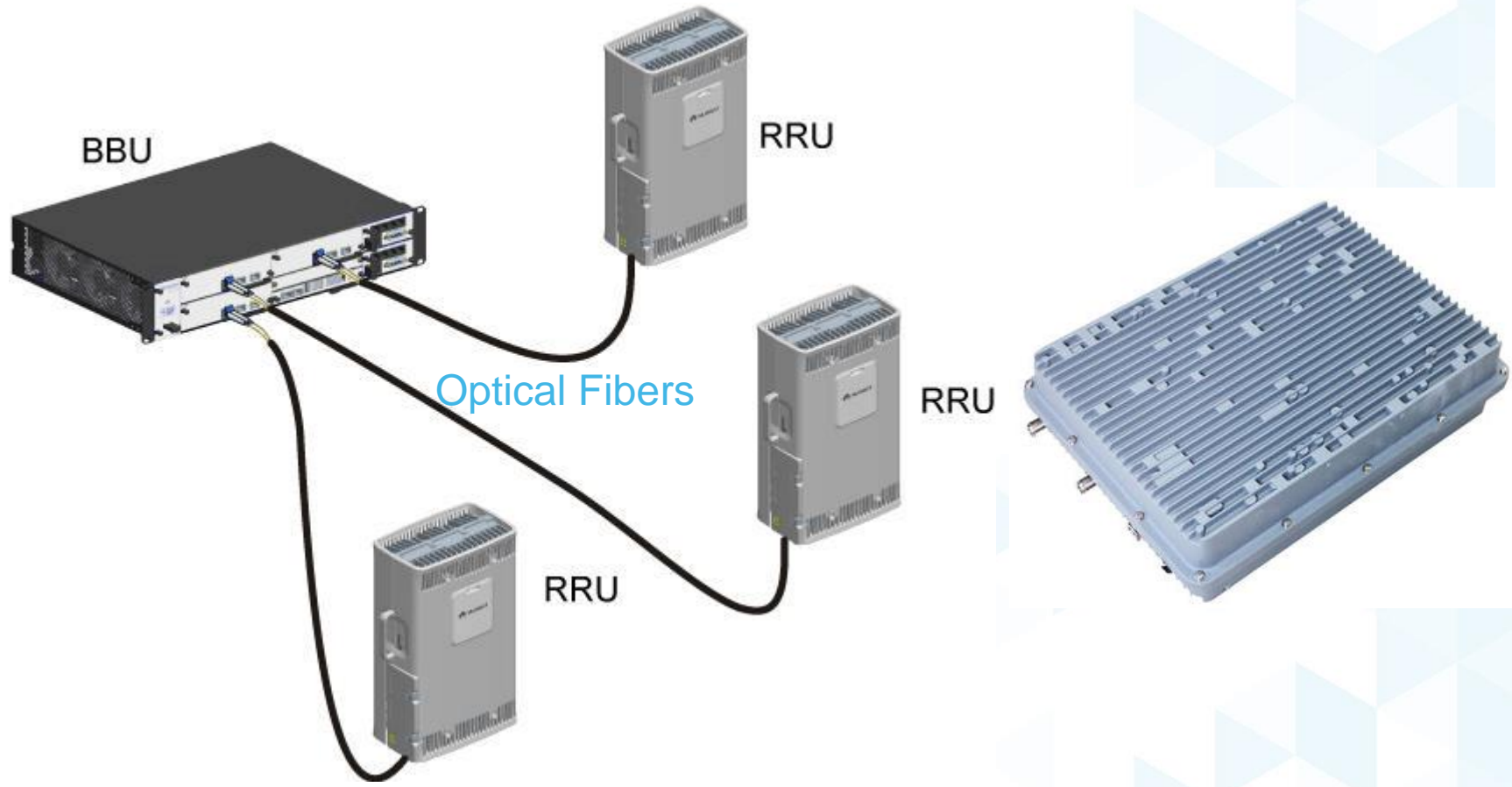




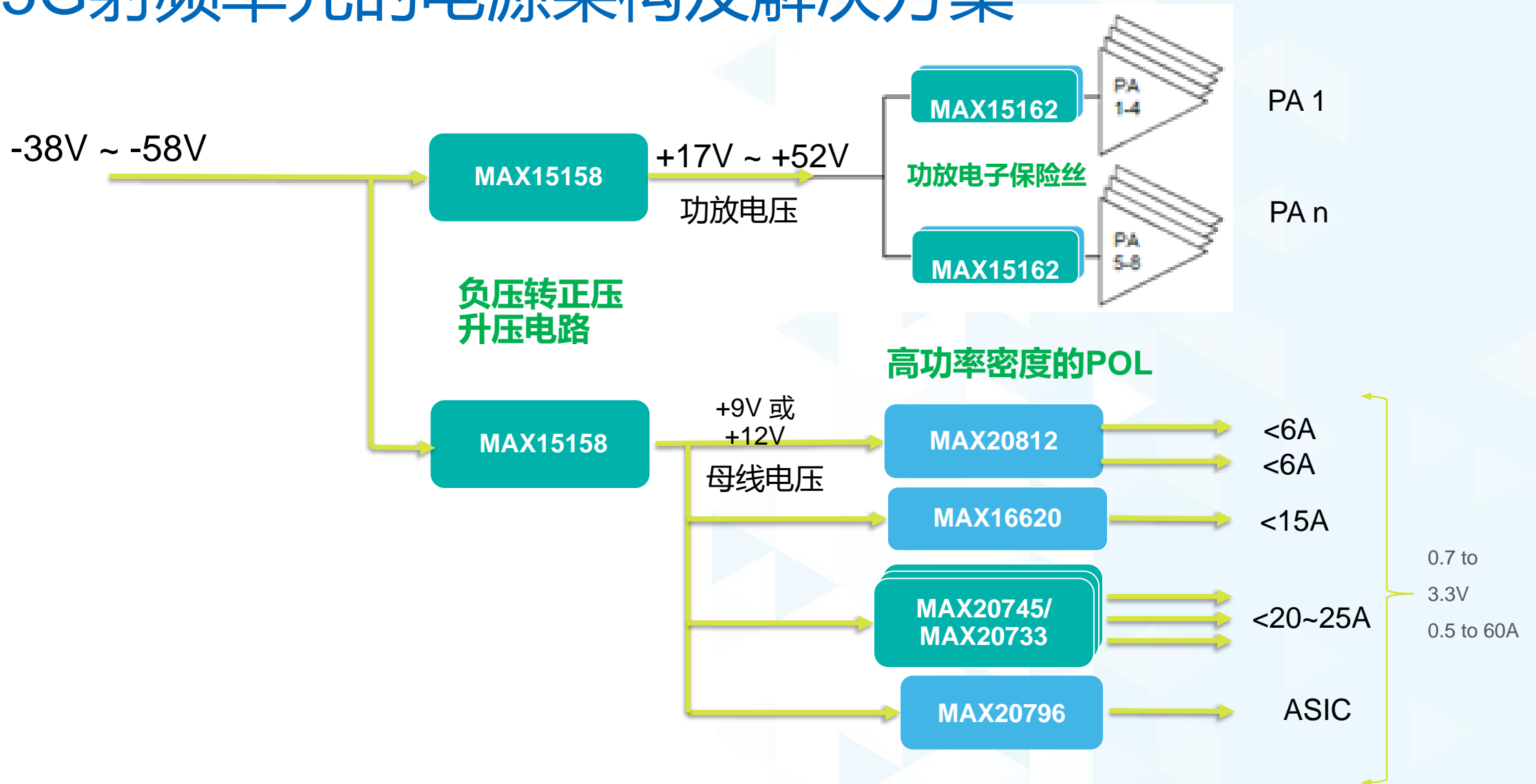
## 2.面向5G应用的高功率电源解决方案



# 5G RRU (Remote Radio Unit)



# 5G射频单元电源架构及解决方案



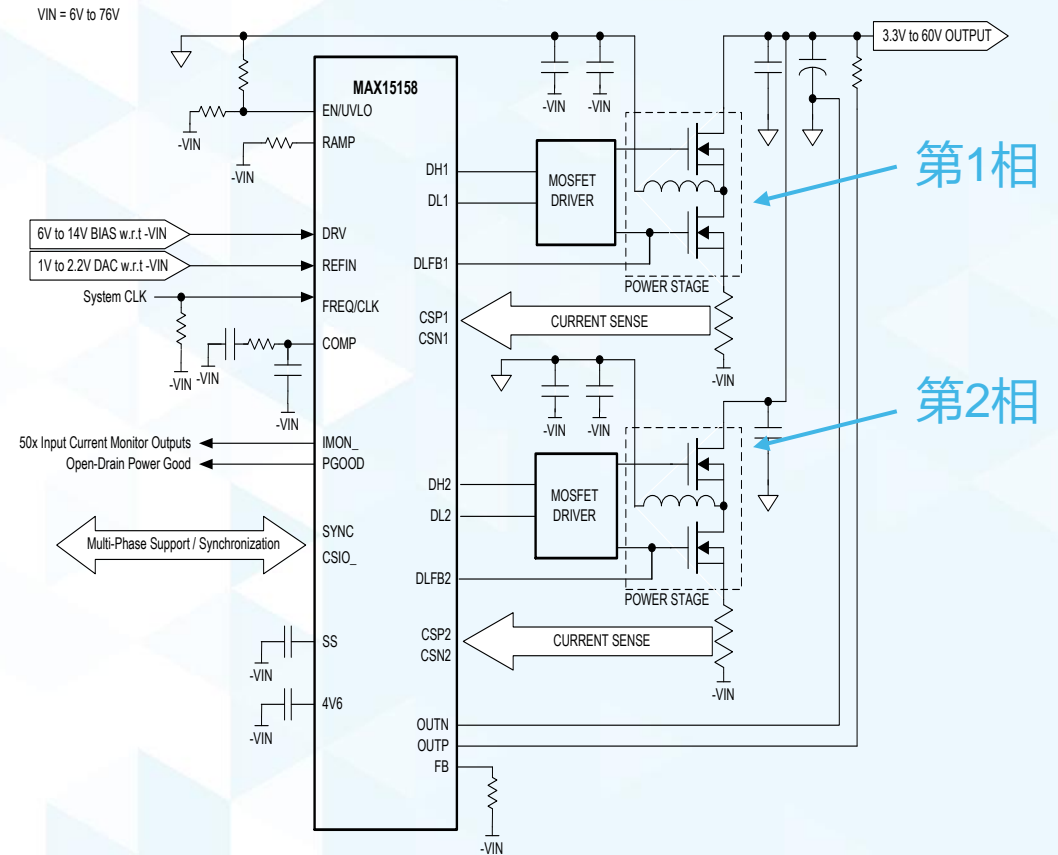
# MAX15158/15159 – 高压多相升压控制器

## 主要优点

- 双相高集成度
- 内置了高边电压采样反馈电路，无需外加电压转换电路
- 集成了非常可靠错误保护功能，以提高产品质量及简化系统设计，如过流/短路，过压，欠压及过温保等

## 主要功能

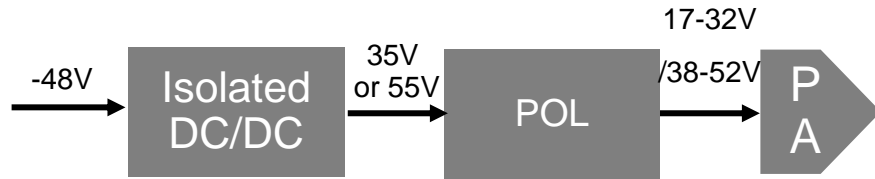
- 输入电压范围: -6V 到 -76V
- 输出电压范围: 3V 到 56V
- 开关频率范围: 120kHz to 1MHz
- 可以从单相扩展到两相和四相 (2 x IC) 工作模式
- 内置了偏置电源的LDO
- 内置了斜坡补偿功能
- 开关频率支持外部时钟同步
- 过压, 欠压, 过流等保护
- 工作温度范围: -40°C to +125°C
- 封装: 32-pin, 5mm x 5mm QFN



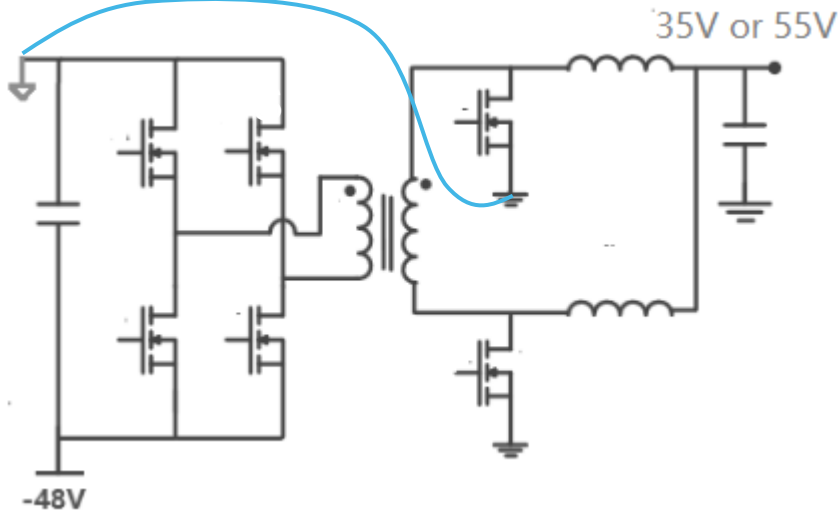
# 为什么需要MAX15158

可以省掉隔离变压器,大大简化设计

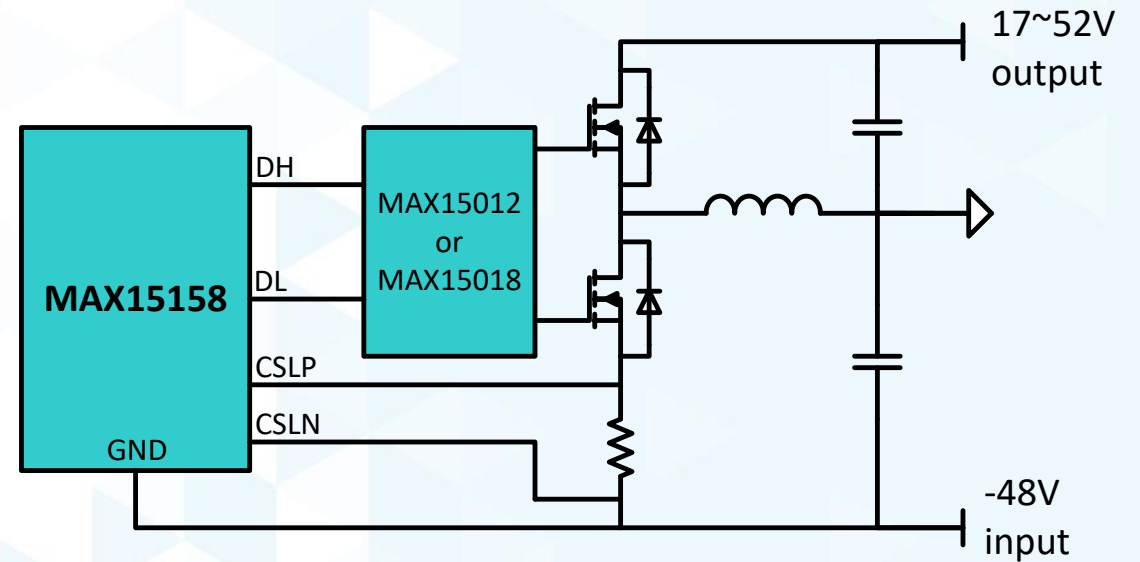
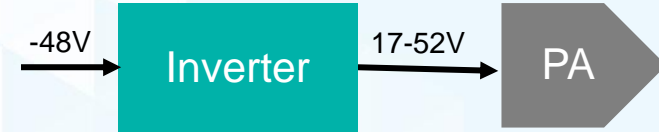
-48V隔离转换电路



通过机壳短接



Buck-boost电路可以不使用变压器  
实现负电压转正电压

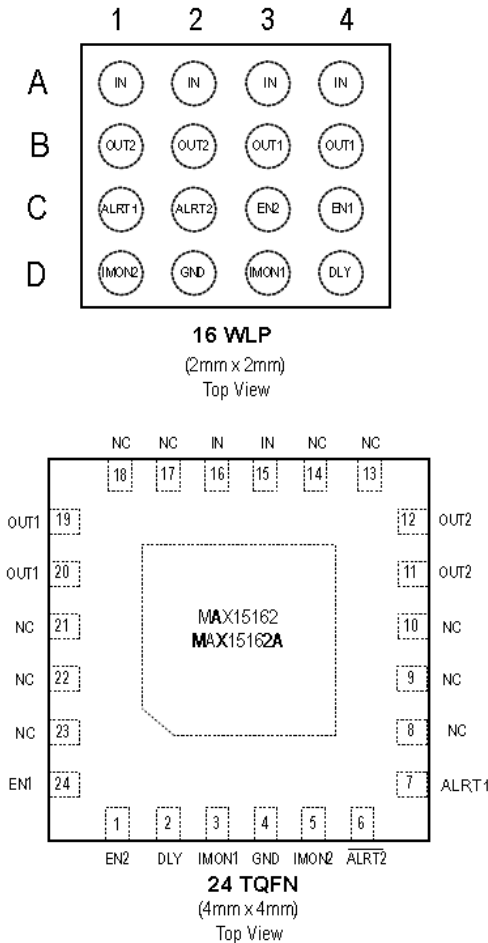


# MAX15162, 功放电子保险丝

8V to 60V 高集成度双通道断路器

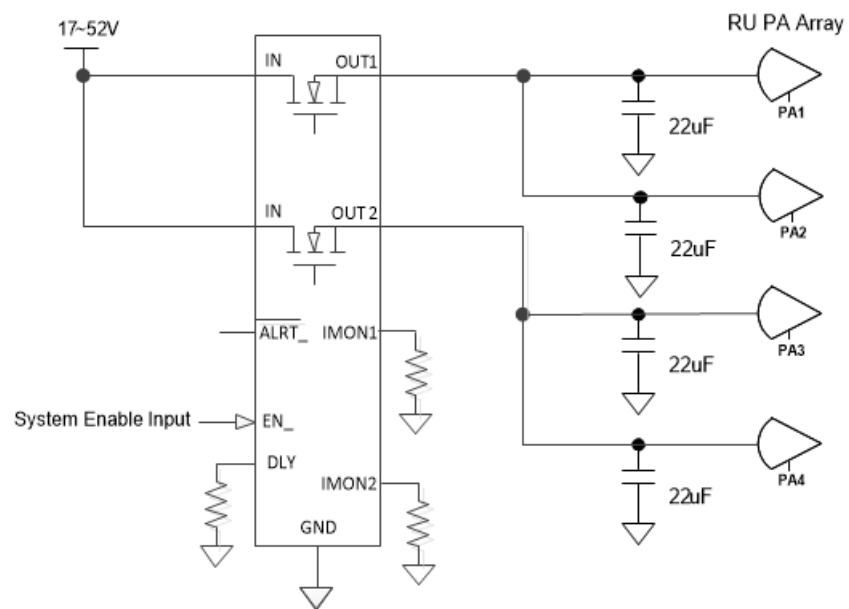
## 功能介绍

- ▶ 8V to 60V 宽输入电压范围
- ▶ 内置双路功率Mosfet
  - Mosfet 导通电阻: 140mΩ(Typ, WLP), 180mΩ(Typ, TQFN)
  - 双通道可独立工作, 或并联工作
- ▶ 基于MosFet SOA的冲击电流控制, 及在上电过程中多级的过流保护
- ▶ 过流门限及关闭延迟时间可调整
- ▶ 过流及过温保护告警指示
- ▶ 欠压锁定保护
- ▶ 集成过热关断保护功能
- ▶ 错误事件后自动重启 (MAX15162A), 错误事件后锁定 (MAX15162)
- ▶ 每路独立的电流上报精度在+/- 3%以内

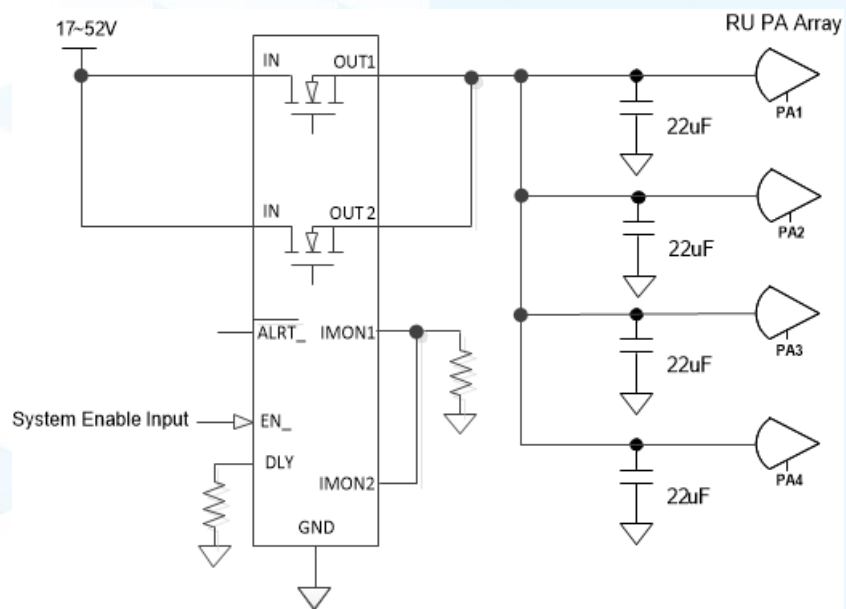


# MAX15162 典型应用电路

## 双路独立工作模式



## 两路并联工作模式



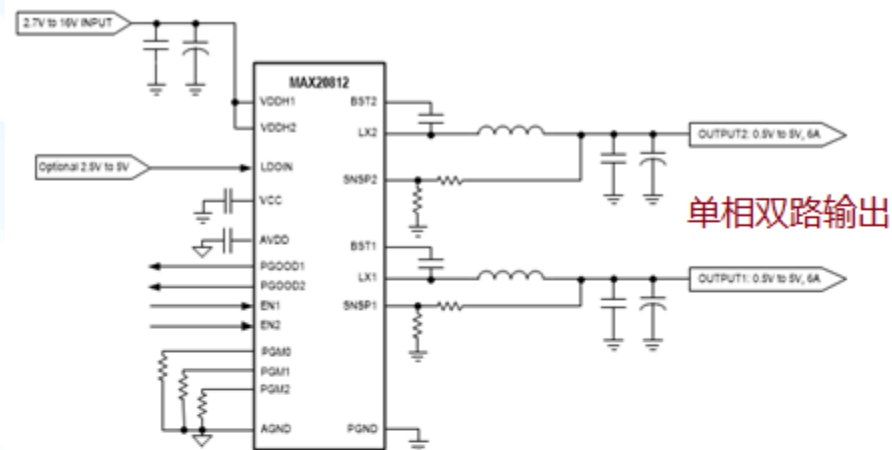
# MAX20812 3MHz 双路6A, 降压开关型变换器

## 主要优点

- 业内最紧凑的小封装
- 大大减少输出电容
- 可灵活配置成单相双路和双相单路输出

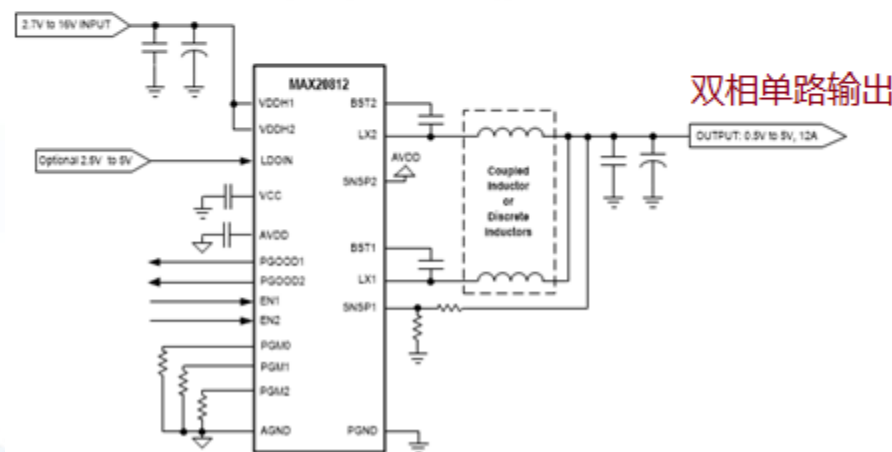
## 主要功能

- 输入电压范围: 2.7V - 16V
- 输出电压范围: 0.5V - 5.8V
- 工作温度范围: -40C to +125C
- 工作频率范围: 500kHz - 3MHz
- 同时支持互为交错的6A双路输出, 和双相单路12A输出
- 同时支持耦合电感和分立电感(贴片电感)
- 工作模式可选
  - 固定频率
  - DCM/AMS
- 3个 PGM 引脚可用来设定过流点, 开关频率, 环路补偿参数
- 每路独立的使能及Power Good指示
- 单路输出模式下支持差分远端反馈
- 封装: FC2QFN-21, 3.5mm x 4.6mm  
WLP-28, 2.1mm x 3.5mm



单相双路输出

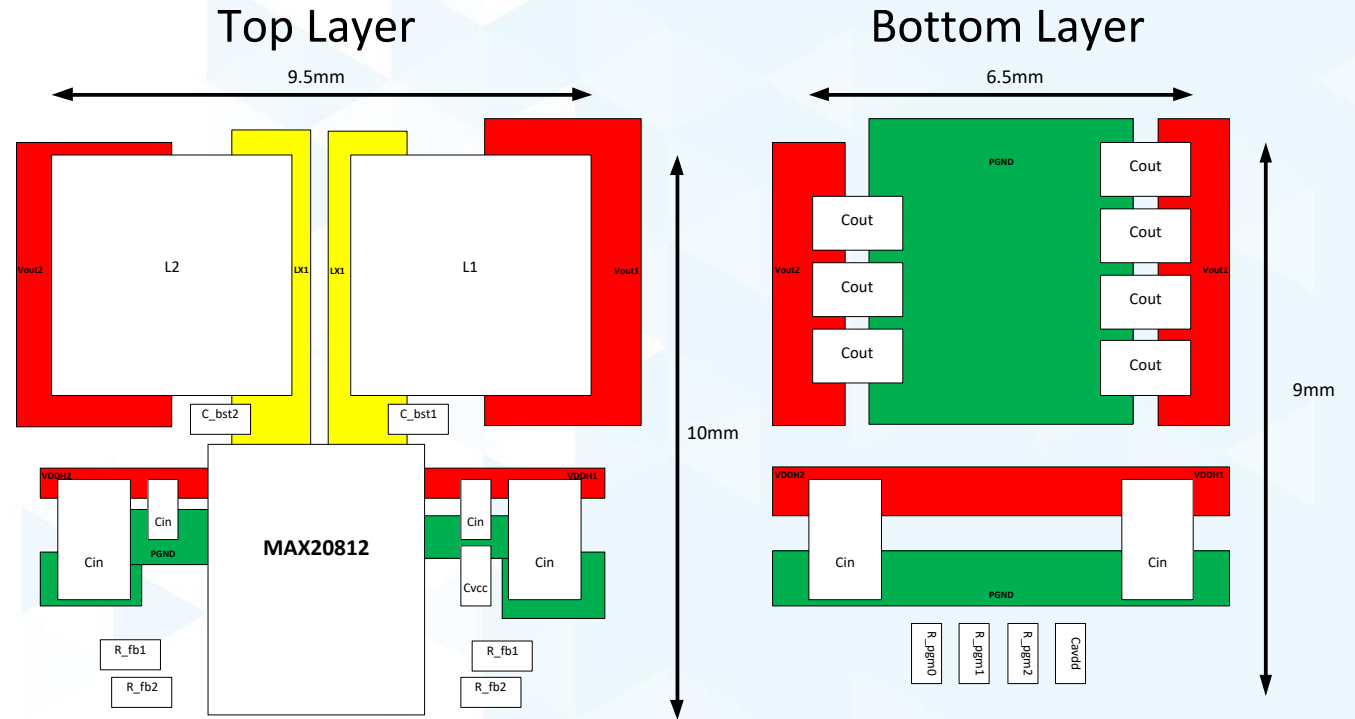
Single-Output Dual-Phase Application Circuit



双相单路输出

# MAX20812 主要器件及PCB布局样板

- ▶ 主控芯片: MAX20812
- ▶ 第1路: 12V输入, 0.9V/6A输出
  - 开关频率: 1MHz
  - 电感: 330nH/9.6A, 4.1mm x 4.1mm
  - 输入电容: 2x 10uF + 1x 0.1uF
  - 输出电容: 4x 22uF (0805)
- ▶ 第2路2: 12V输入, 1.8V/4A 输出
  - 开关频率: 2MHz
  - 电感: 330nH/9.6A, 4.1mm x 4.1mm
  - 输入电容: 2x 10uF + 1x 0.1uF
  - 输出电容: 4x 22uF (0805)





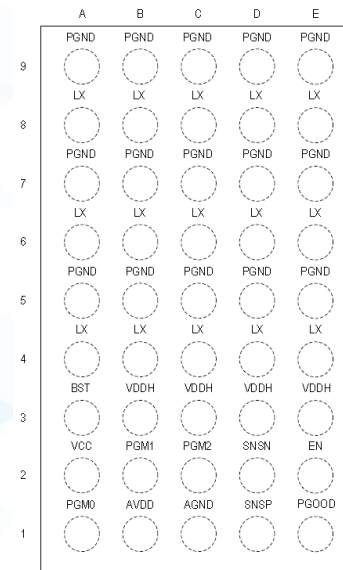
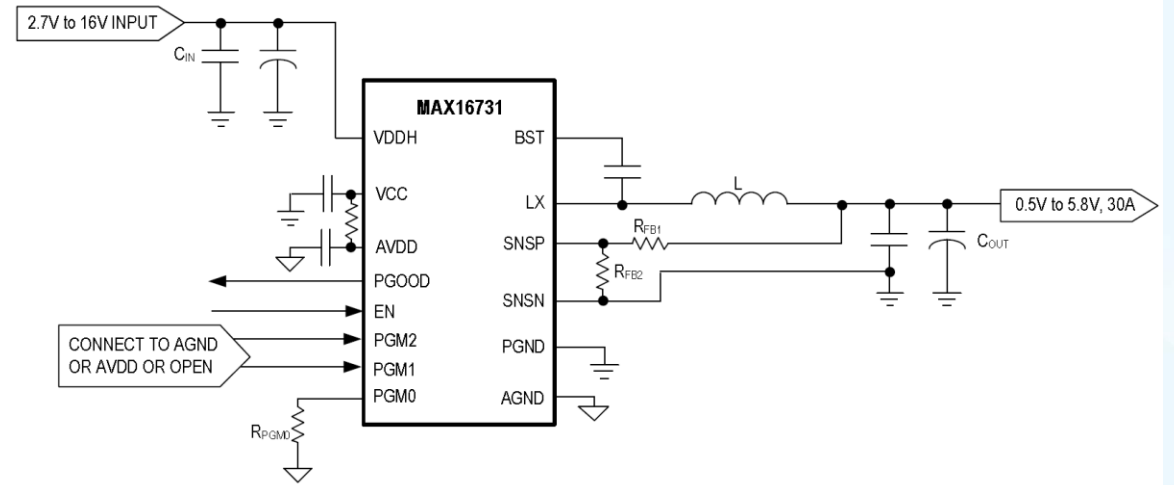
# MAX16731 1.5MHz 30A, 高集成的降压开关型变换器

## 主要优点

- 业内最紧凑的小封装
- AMS提升动态性能, 大大减少输出电容
- 可通过PGMx电阻灵活配置工作模式及环路参数

## 主要功能

- 输入电压范围: 2.7V - 16V
- 输出电压范围: 0.5V - 5.8V
- 工作温度范围: -40C to +125C
- 工作频率范围: 500kHz - 1.5MHz
- 工作模式可选
  - 固定频率
  - DCM/AMS
- 3个 PGMx引脚可用来设定过流点, 开关频率, 环路补偿参数
- 使能及Power Good指示
- 支持差分远端反馈
- 封装: WLP-45, 2.52mm x 4.89mm



# 可扩展的双相60A PoL

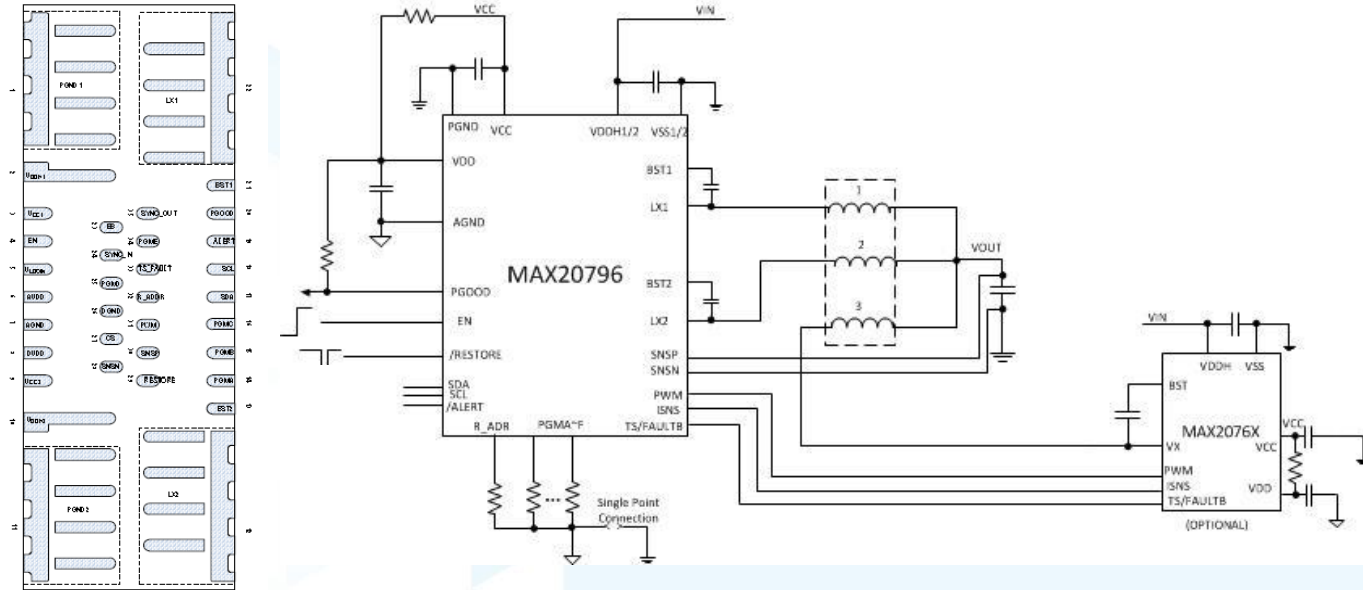
## MAX20796

### 主要优点

- 高集成度，双相集成在同一芯片内
- 减少60%的面积
- 外部增加一个功率Mosfet可支持90A电流输出
- 兼容耦电感设计，具有更快的负载动态响应能力，可以使用更少的输出电容以节省成本
- 双面散热设计

### 主要功能

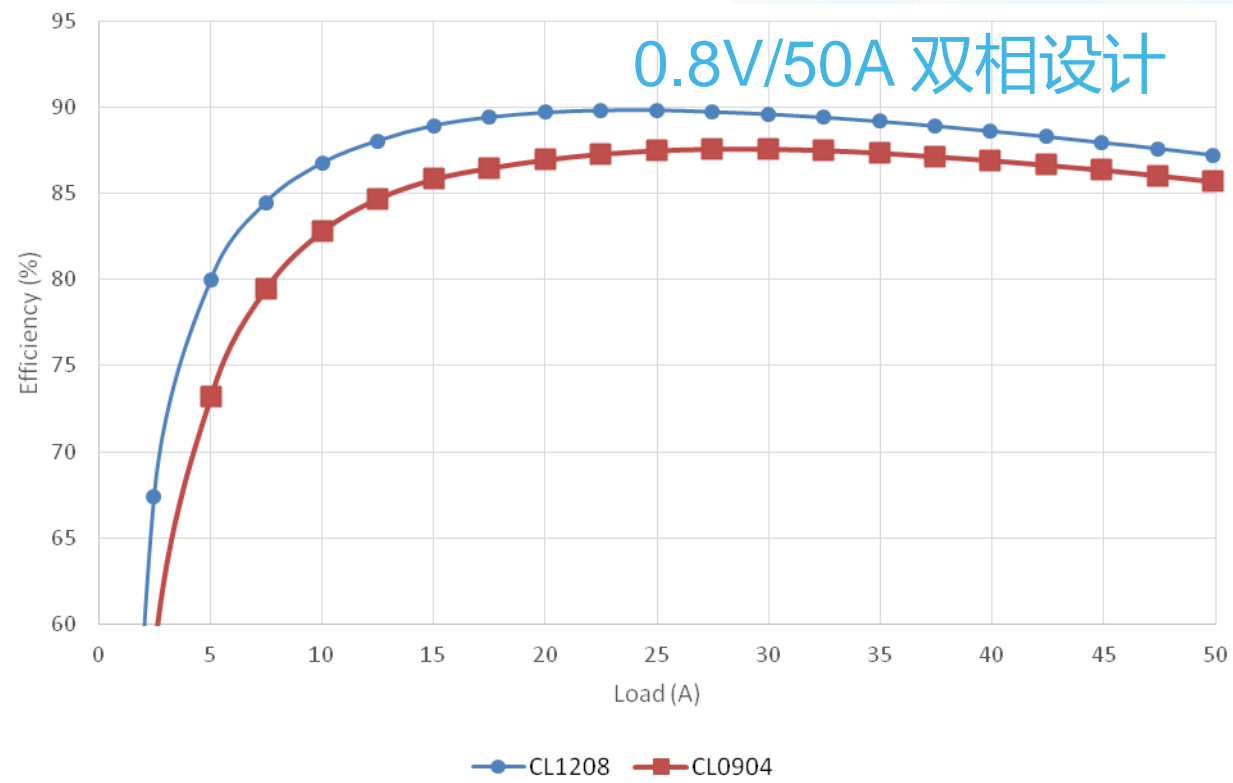
- 输入电压范围： 4.5V - 16V
- 输出电压范围： 0.5V - 5.5V
- 输出电压精度在 +/-1%以内，Tj= -40°C 到 125°C
- 开关频率范围： 每相300kHz-800kHz
- 双相功率Mos集成在单一芯片上
- 集成1.8V LDO为门极驱动电路供电
- 集成环路补偿电路
- 差分远端电压采样
- 集成了过流/短路，过压，欠压及过温保等保护功能
- 封装 FC2QFN-35pin 4mm x 10.5mm



Availability	Date
样品及评估板	现在
量产	July 2018

# MAX20796效率曲线

12V输入, 0.8V输出, 开关频率每相400kHz  
包括3.3V的偏置电源损耗, 无风常温



CL1208-2: 100nH 8mm高  
CL0904-2, 50nH, 4mm高

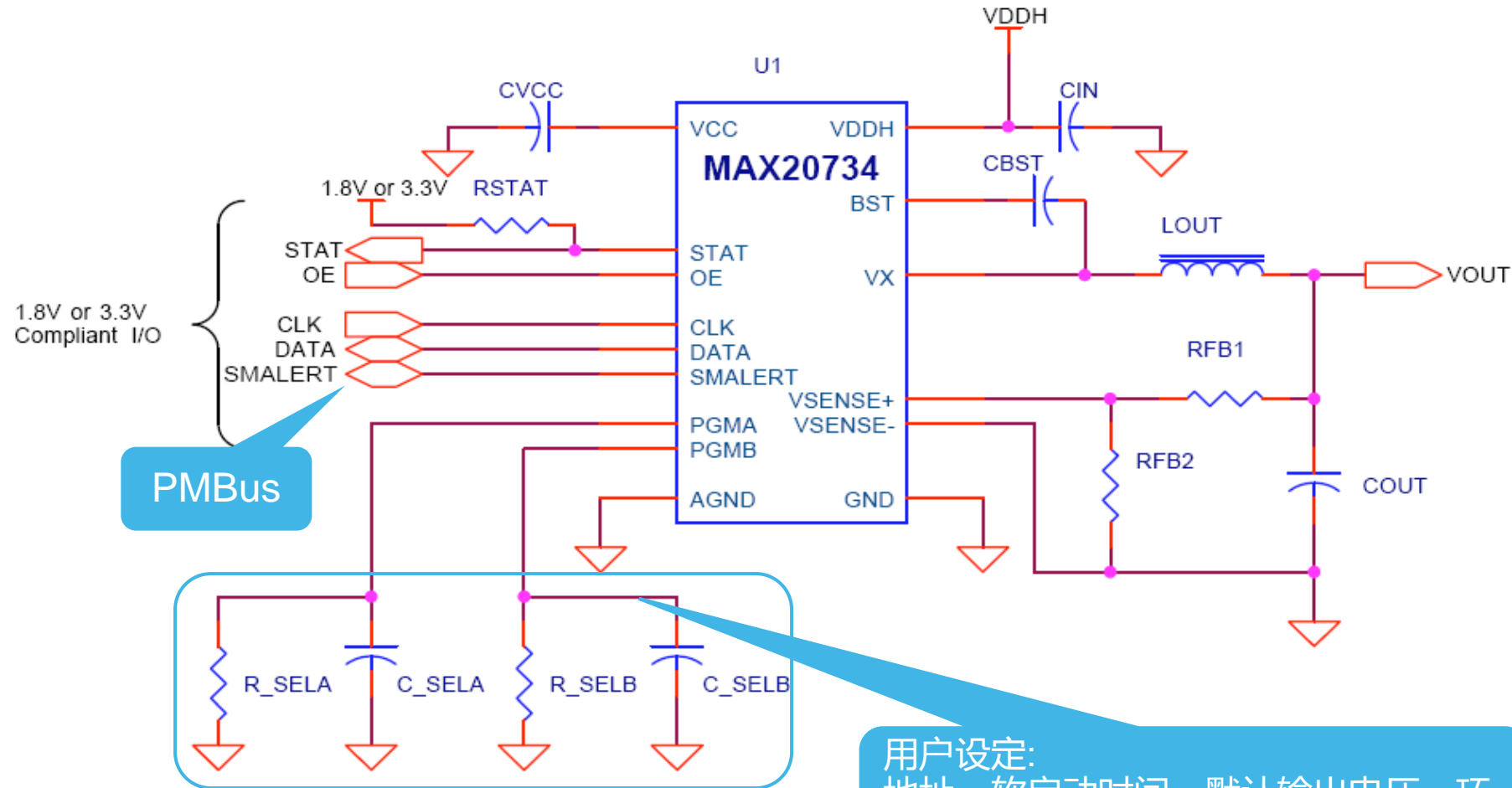
# MAX2073x/MAX2074x 系列PoL

	<b>25A</b>	<b>35A</b>	<b>40A</b>
PMBus	MAX20730	MAX20743	MAX20734
Non-PMBus	MAX20745	MAX20733	MAX20735

## 主要功能:

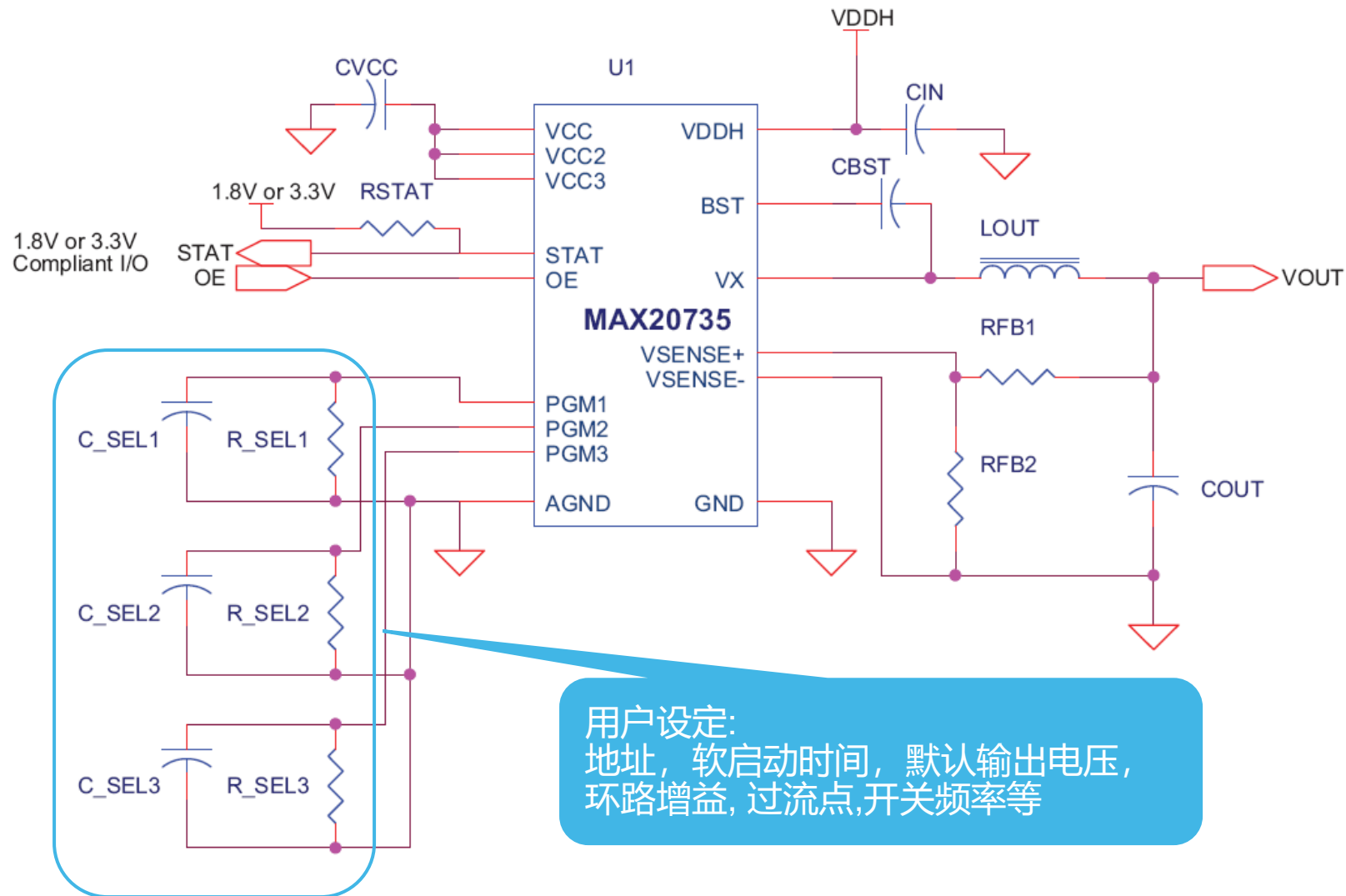
- 输入电压: 4.5V~16V
- 输出电压: 0.65~5.5V
- 开关频率: 400kHz/500kHz/600kHz/700kHz/800kHz/900kHz
- 初始输出电压: 0.65V/0.9V/1V
- 软启动时间: 0.75ms/1.5ms/3ms/6ms
- 过流保护点可设
- 可配置性强 (H/W, PMBus)
- 简化的控制架构 ---无需外加补偿网络

# MAX20734典型应用电路 - 带PMBus



用户设定:  
地址, 软启动时间, 默认输出电压, 环路增益, 过流点, 开关频率等

# MAX20735典型应用电路 - 不带PMBus



用户设定:  
地址, 软启动时间, 默认输出电压,  
环路增益, 过流点, 开关频率等



### 3. Power over Ethernet(PoE) 产品及应用技术

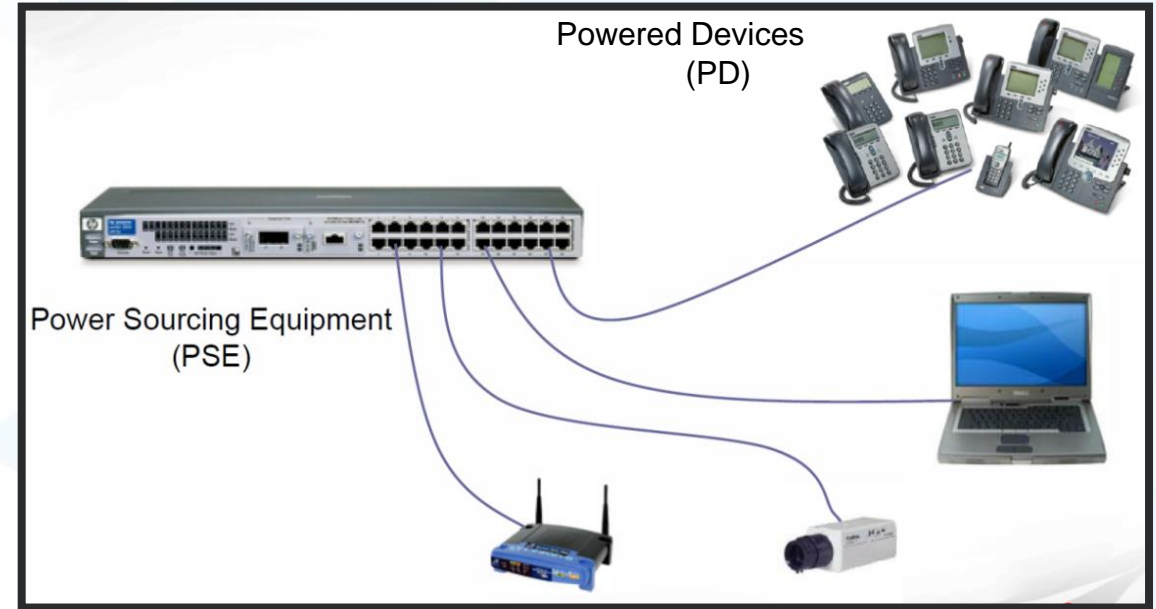
# Power over Ethernet (PoE)

## Description

- ▶ Power over Ethernet (PoE) allows data and power to be transmitted to remote devices over standard Ethernet cables
- ▶ IEEE 802.3af/at/bt and LTPoE++ standards ensure device compatibility

## Benefits

- ▶ **Easy Installation** - Deliver data and power over a single cable
- ▶ **Increased Safety** - Eliminate AC wall adapters
- ▶ **Worldwide Use** - Standardized power
- ▶ **System Monitoring** - Central power management

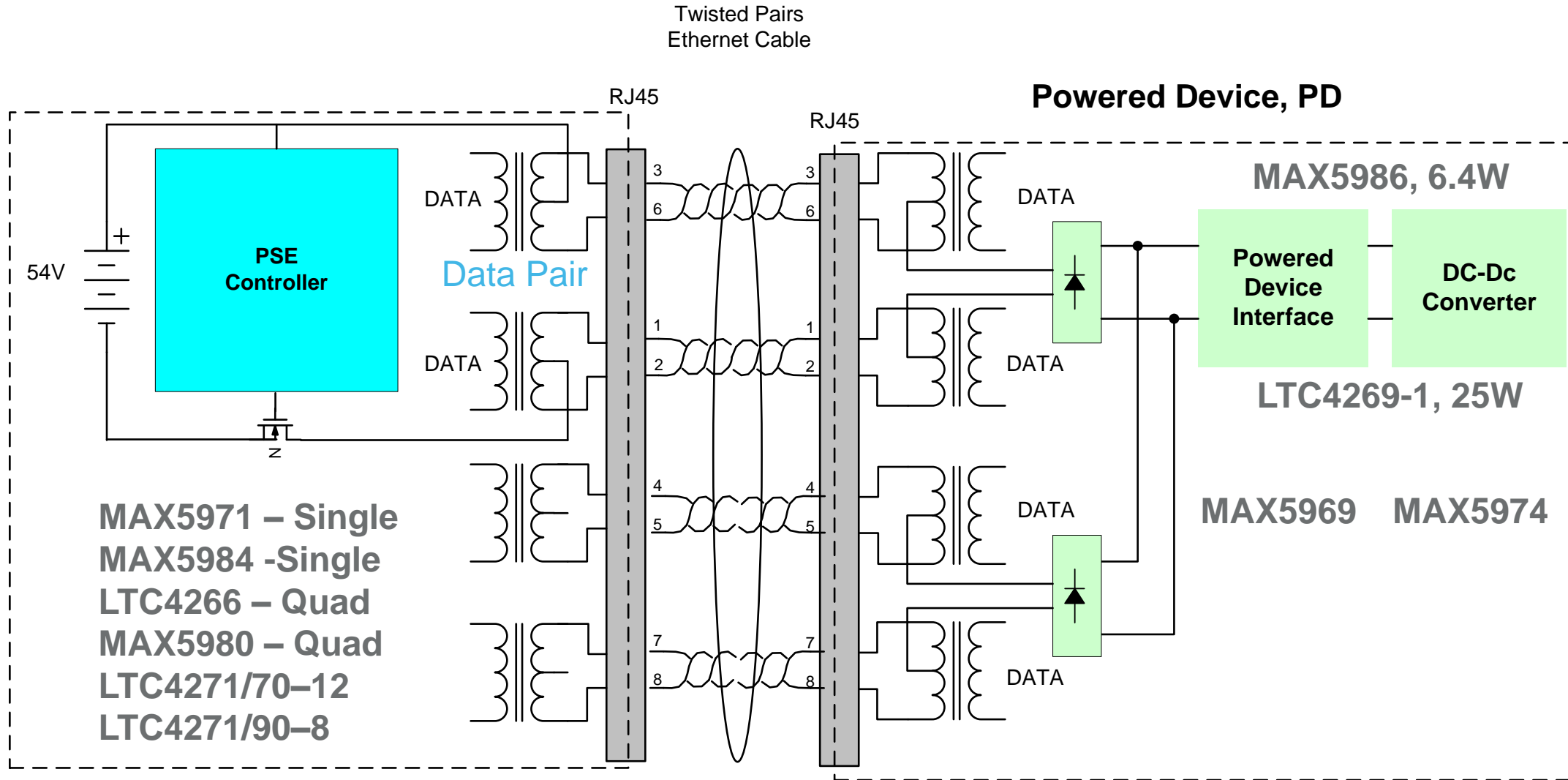


Standard	Release Year	PoE Type	Max Delivered Power at PD
IEEE 802.3af	2003	Type 1	13W
IEEE 802.3at	2009	Type 2	25.5W
IEEE 802.3bt	2018	Type 3	51W
		Type 4	71.3W
LTPoE++	2016	LTPoE++	90W



# PoE System Block Diagram-End Point

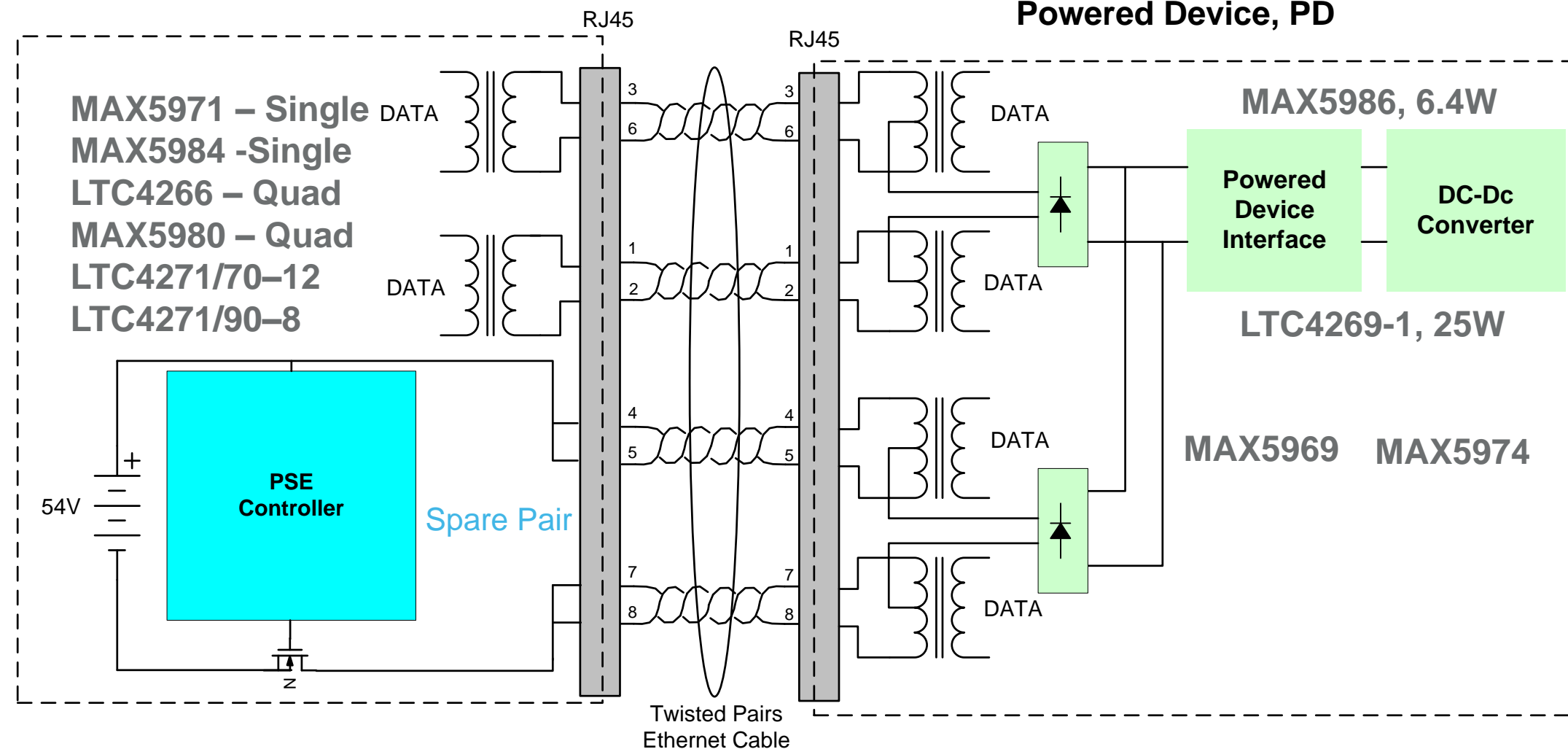
## Alternative A



# PoE System Block Diagram-Mid Span

## Alternative B

### Power Sourcing Equipment, PSE

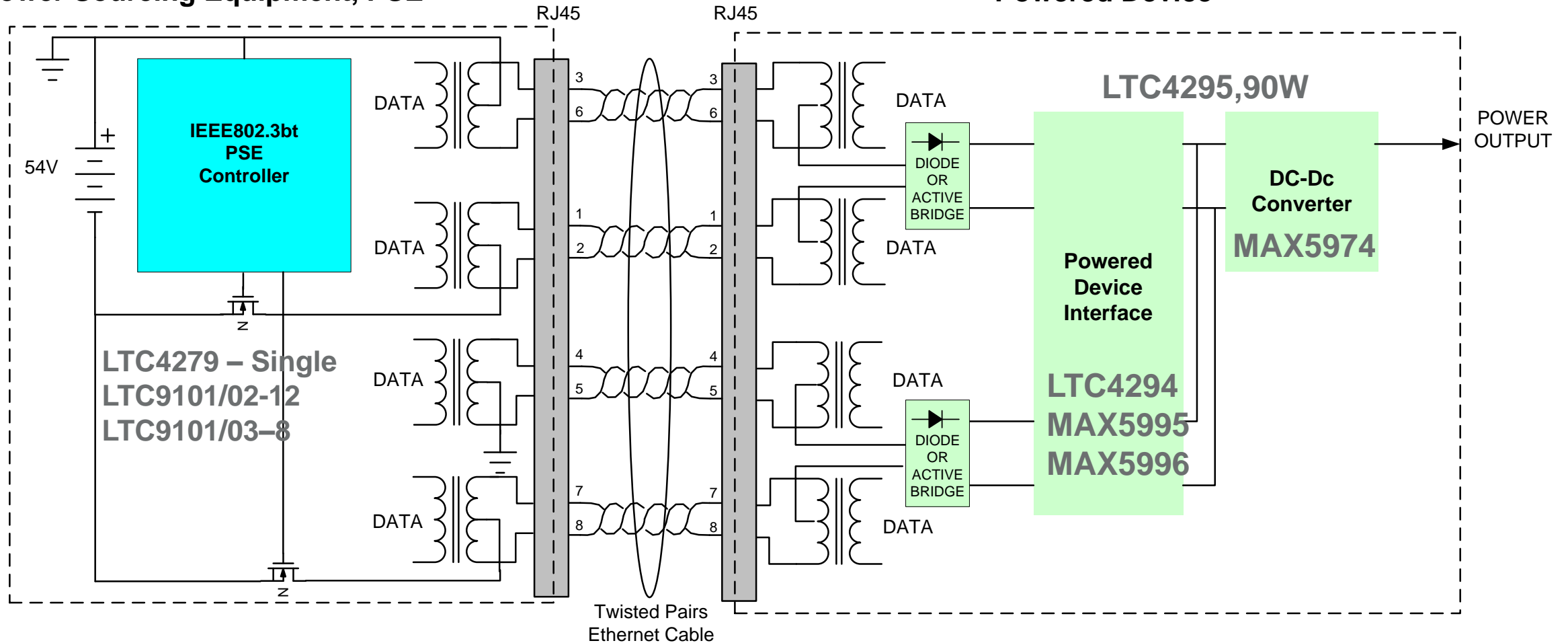


# Type 3,4 - 4PPoE Solution w/ Single-Signature PD

## Alternative C

### Power Sourcing Equipment, PSE

### Powered Device

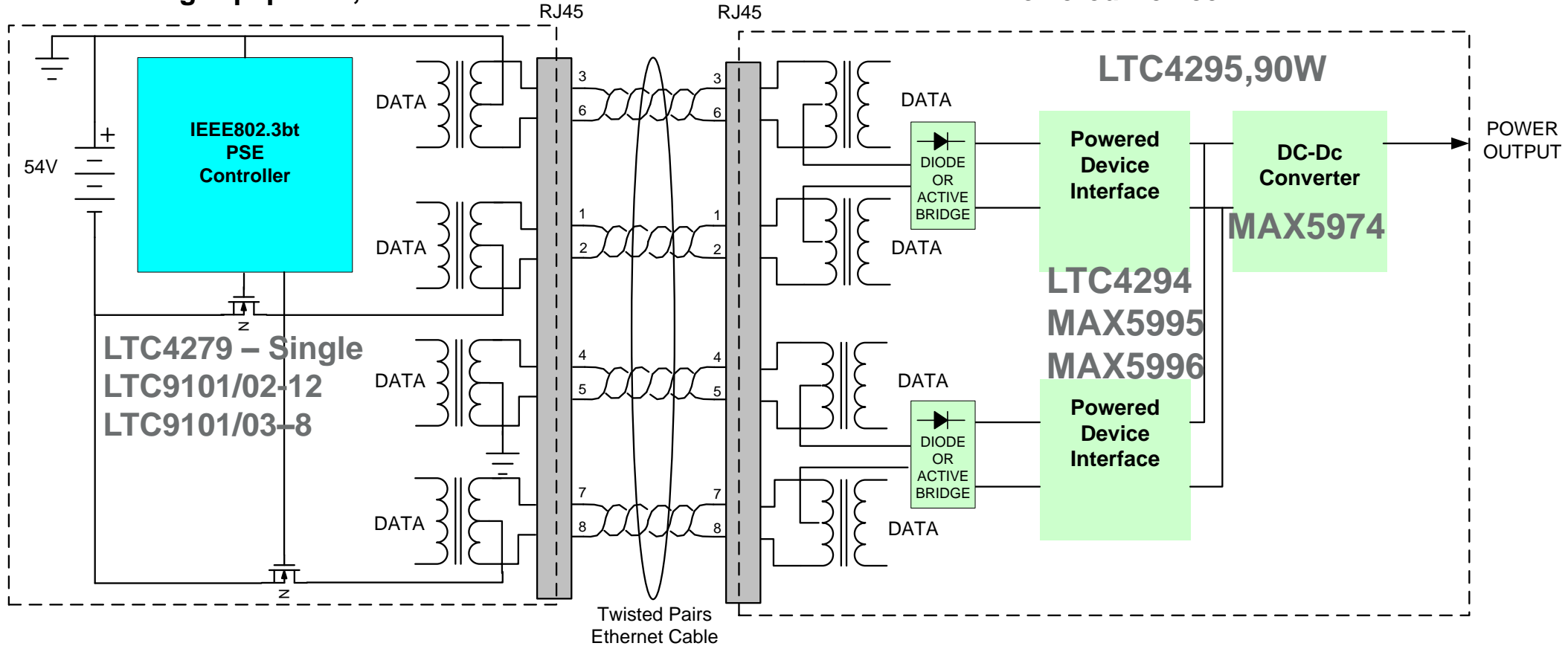


# Type 3,4 - 4PPoE Solution w/ Dual-Signature PD

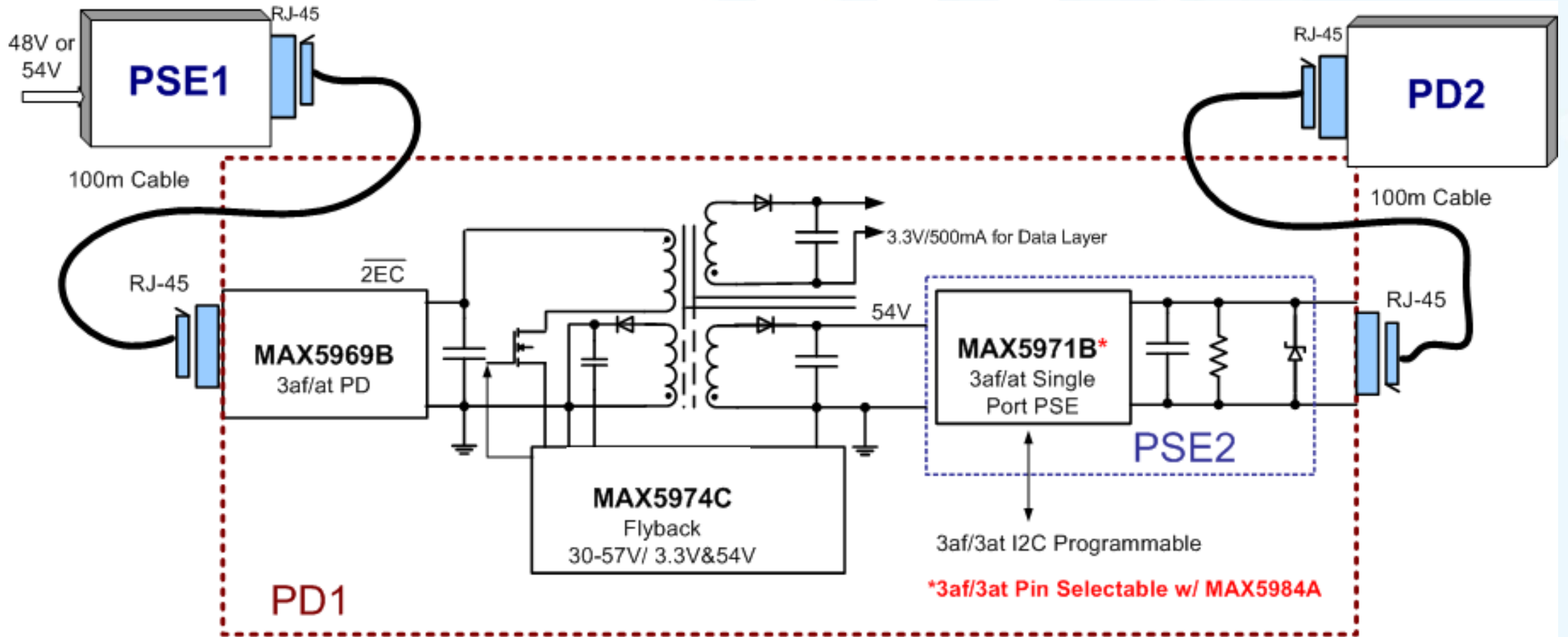
## Alternative C

### Power Sourcing Equipment, PSE

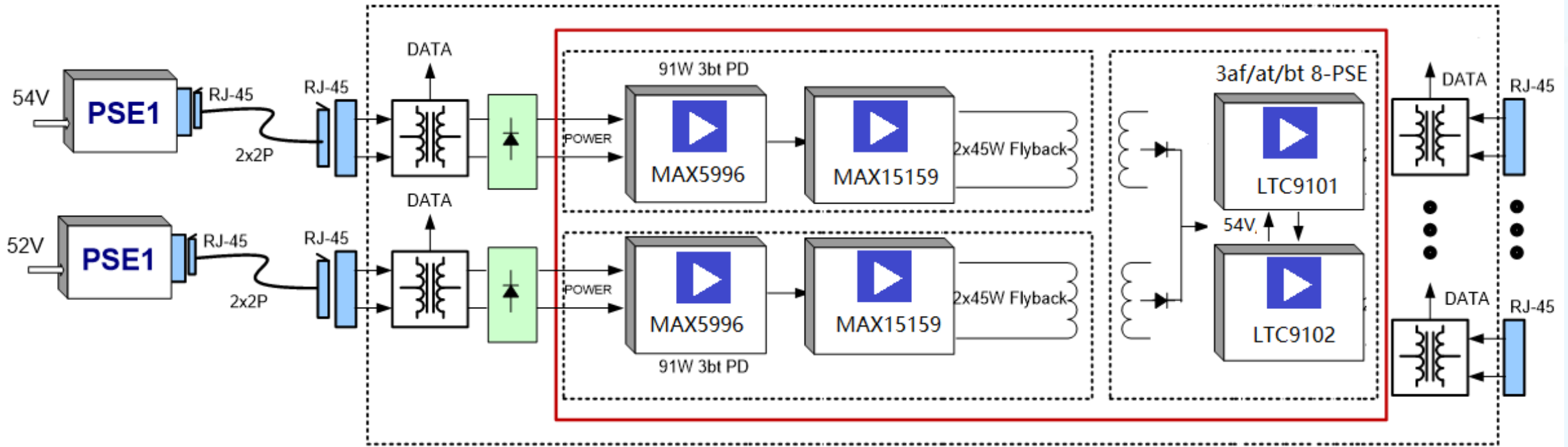
### Powered Device



# Single-Port Repeater



# Multi-Port Repeater



# Plug & Play: Everywhere Connected



IP-Phone



IP-Camera



Wireless-AP



IP-Lighting



IP-Door Ctrl



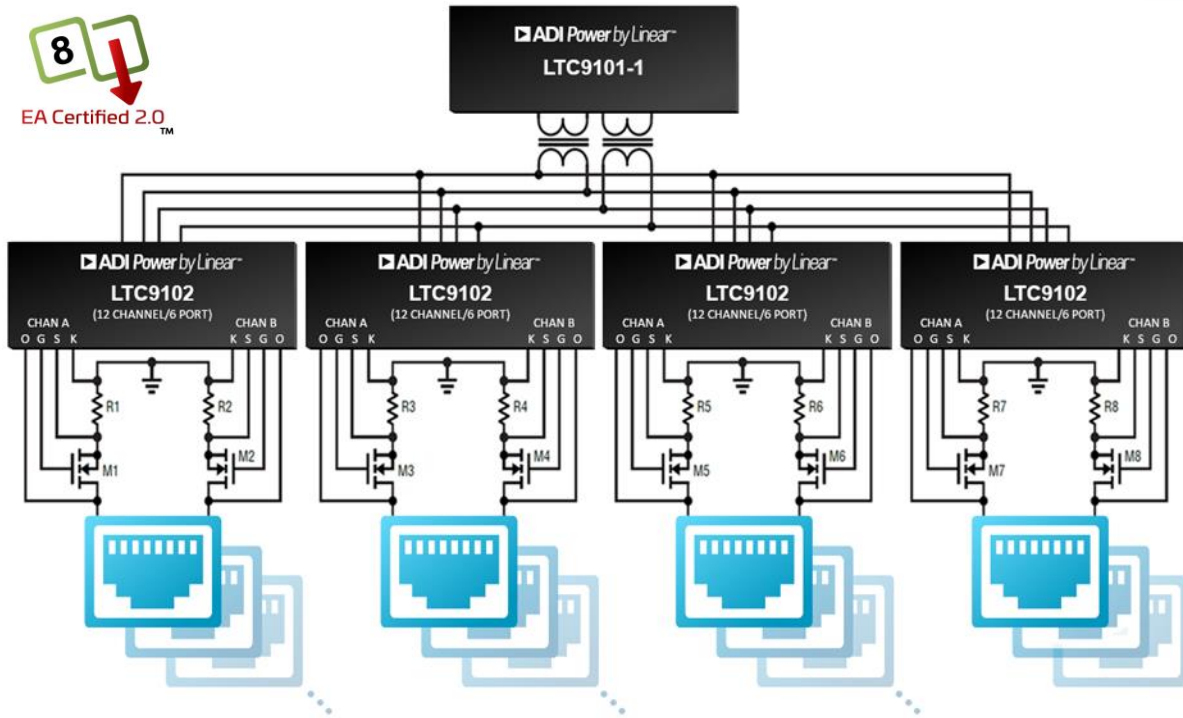
Roadside Unit



**eBuilding**

# Introducing: LTC9101/9102/9103

## PoE PSE 4-Port to 48-Port Chipset



### ► Cost-reduced BOM

- Shared Digital Controller and Transformer
- Reduced Component Count
- No I<sup>2</sup>C nor 3.3V Isolation Required



Industry-lowest power dissipation



Parallel Detect/Class

- All channels detect/class simultaneously

Configurable Identity



- AT/BT single-channel ports (to 48 ports)
- BT dual-channel ports (to 24 ports)
- Mix allowed



Hot swap loop improvements

- Immediate recovery from surges



# Footprint Compatible Channel Controllers

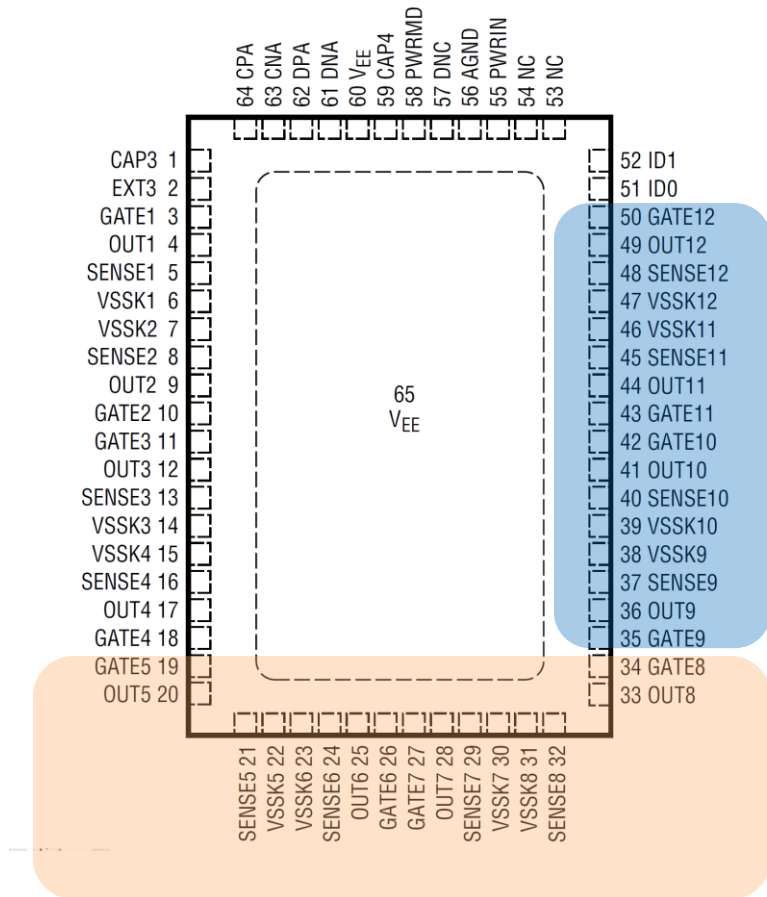


## LTC9102

### 12-Channels

LTC9102

TOP VIEW



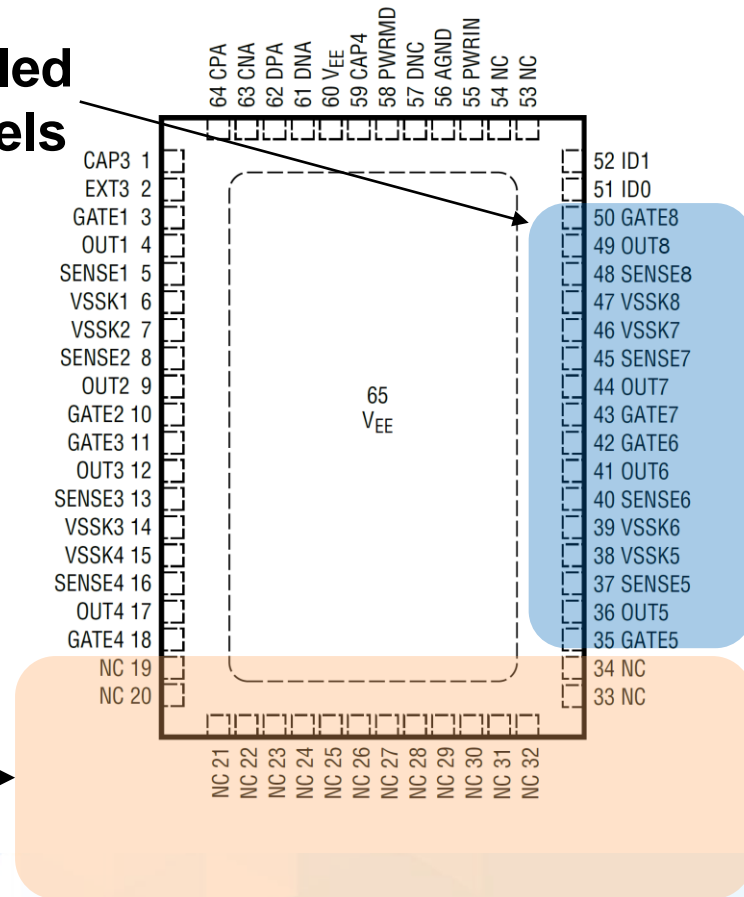
**Relabeled  
Channels**

## LTC9103

### 8-Channels

LTC9103

TOP VIEW



**Removed  
Channels**

# Scalability & Flexibility

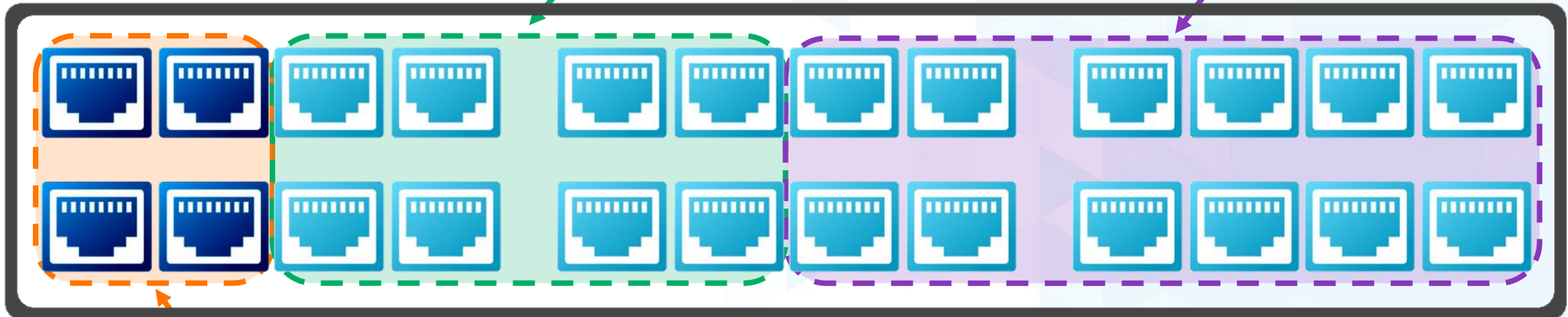


## ▶ 24-Port Sample System – af/at/bt Configurable

- (4) 4P ports (2 channels)
- (20) 2P ports (1 channel)
- Total channels 28
  - (1) LTC9102
  - (2) LTC9103

LTC9103  
Eight 2-pair ports  
8 channels

LTC9102  
Twelve 2-pair ports  
12 channels



LTC9103  
Four 4-pair ports  
8 channels

# 1<sup>st</sup> Digital PD: MAX5996

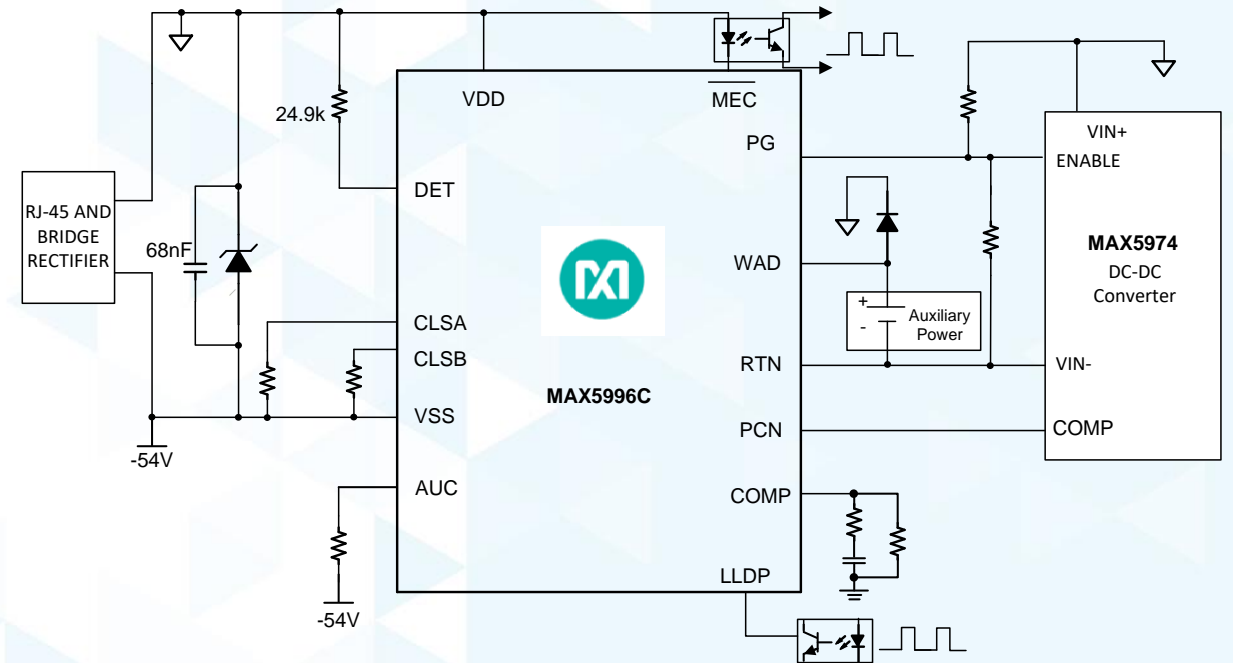
## IEEE 802.3af/at/bt Compliant High Integration 90W PD Controller

### Benefits

- High Integration
- Telemetry through Single Pin Communication
- High Flexibility
- Reliable Power Source

### Key Features

- IEEE802.3bt Compliant
- Built-in 100V 90W 100mΩ (25°C) Isolation Switch
- Proprietary PoE Power Management (**Patent Pending**)
  - Accurate Power Telemetry +/-3%
  - Constant Power/Current Limit +/-3.5%
  - LLDP Reclassification Capability, 350mW/LSB
- Multi-Classification & Single Pin Indication
- Overtemperature Protection
- Selectable Green MPS
- Intelligent MPS (Patent US9152161);
- Simplified Wall Adapter Interface
- Inrush Current Limit During Startup
- Current Limit During Normal Operation
- Pin Compatible with MAX5995A/B, Comparable with MAX5995C
- IPC9592 compliant package in 5mm x 5mm TQFN-16



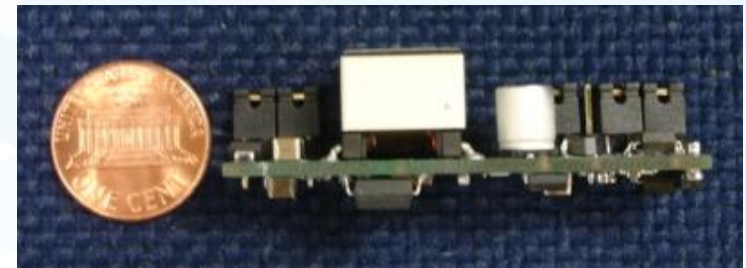
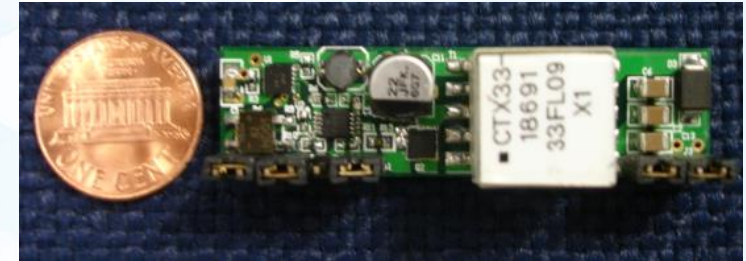
Availability	Date
Samples & EVKit	Now
Mass Production	Now

# Featured PD: MAX5969B + MAX5974A

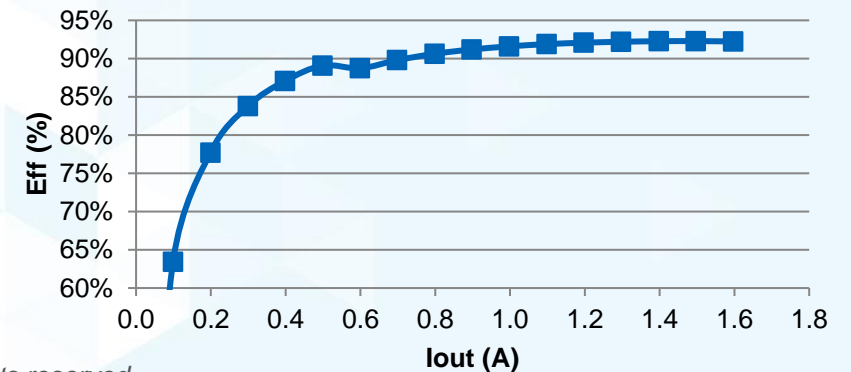
## Compact Type 1 PD Controller + 12V/15W PWM Controller

- ▶ Very Low-Cost Class 3 PD Solution
- ▶ Extremely simple to design in
- ▶ High Efficiency of 92%
- ▶ No Opto-coupler and Shunt Regulator  
Frequency Foldback:
  - Reduces Fsw to half at light load
  - High Efficiency at light load

**Very Low Cost  
and Compact**



**12V EVKIT Efficiency  
@Vin=48V**



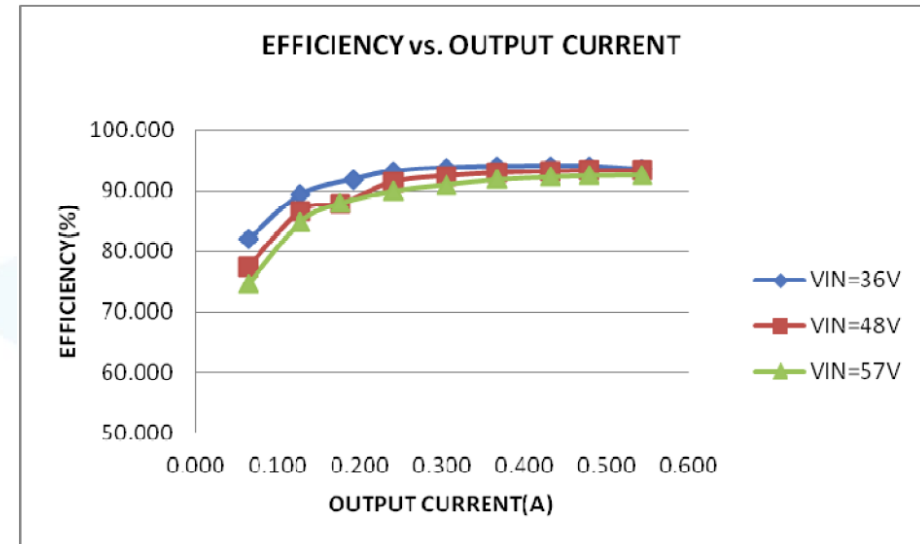
# Featured PD: MAX5986/87

## Compact, Class 2, High Integration PD

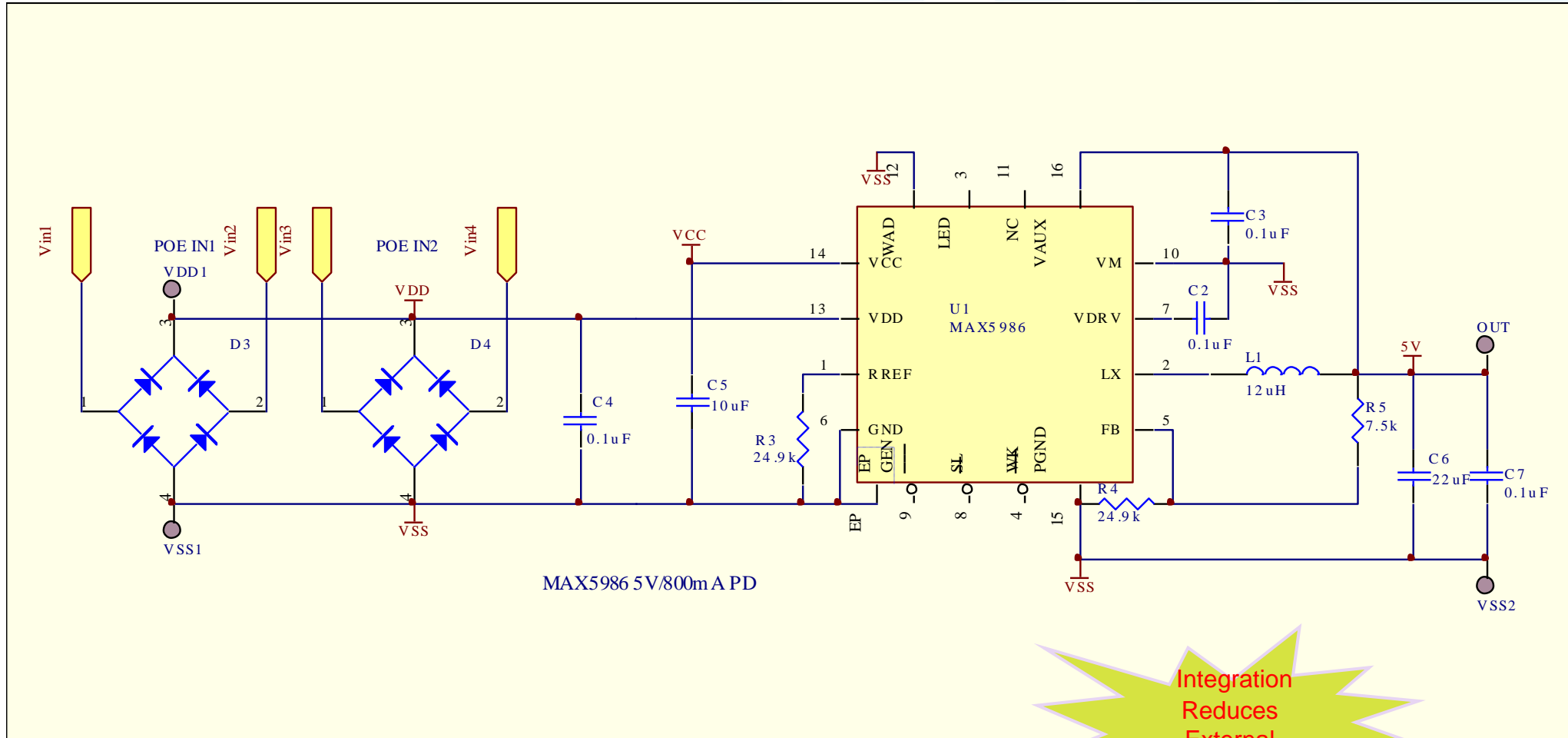
### Features:

- ▶ **40%-60%** Fewer External Components
- ▶ Input Voltage: 33-57V
- ▶ WAD Input Voltage: 30V up to 57V
- ▶ Vout: 12V/ 0.5A; eff: 93.3% (non-isolated)
- ▶ Vout:3.3V/1.6A; eff: 91.3% (isolated)
- ▶ Line and Load Regulation:  $\pm 1\%$
- ▶ Switching Frequency 214kHz
- ▶ Efficient Light Load Operation w/ Frequency Fold-back
- ▶ Pin Selectable MPS

**3.3V Output  
Efficiency >91%**

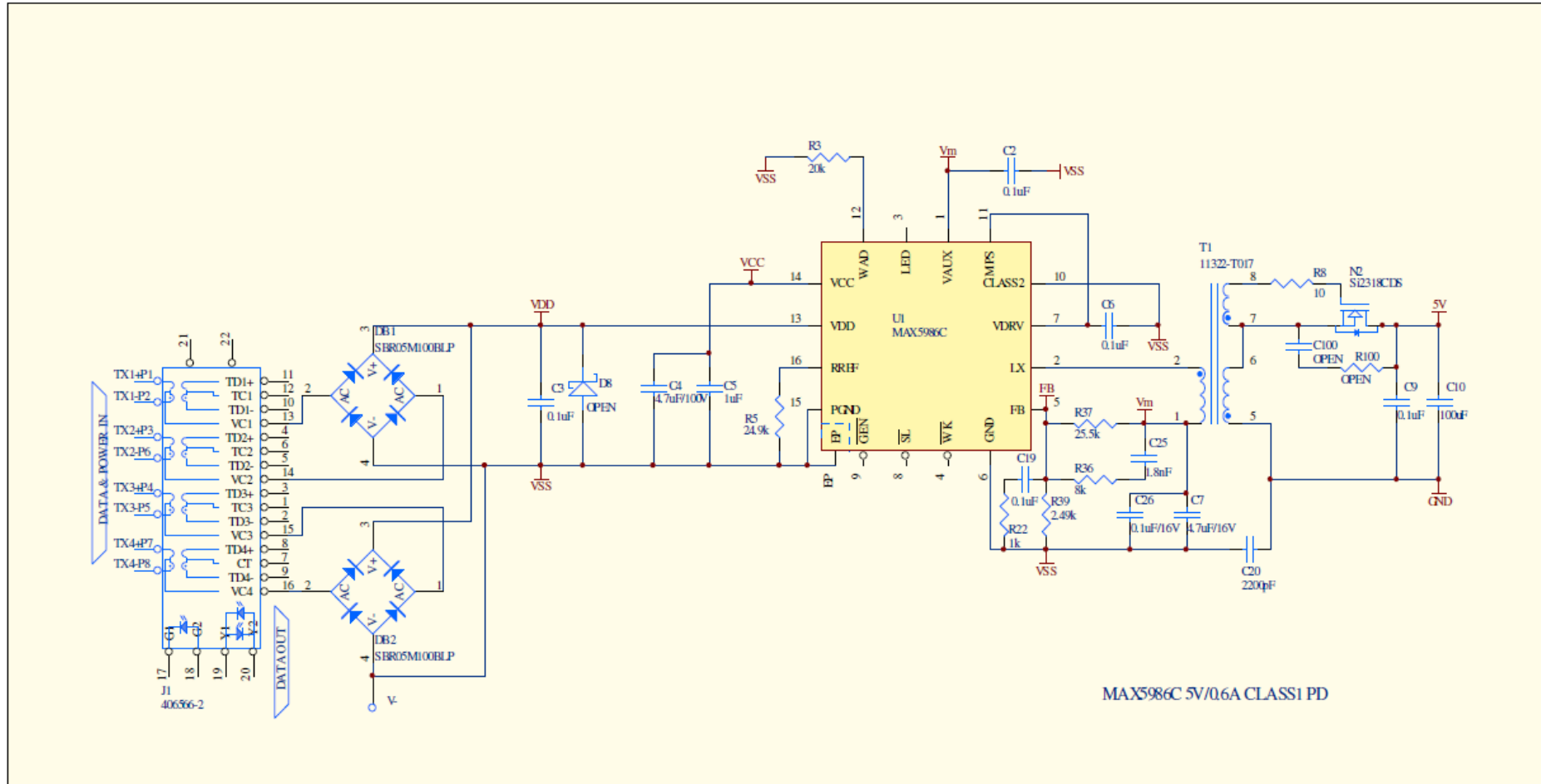


# Class1,2 PD Solution w/ MAX5986



Integration  
Reduces  
External  
Components

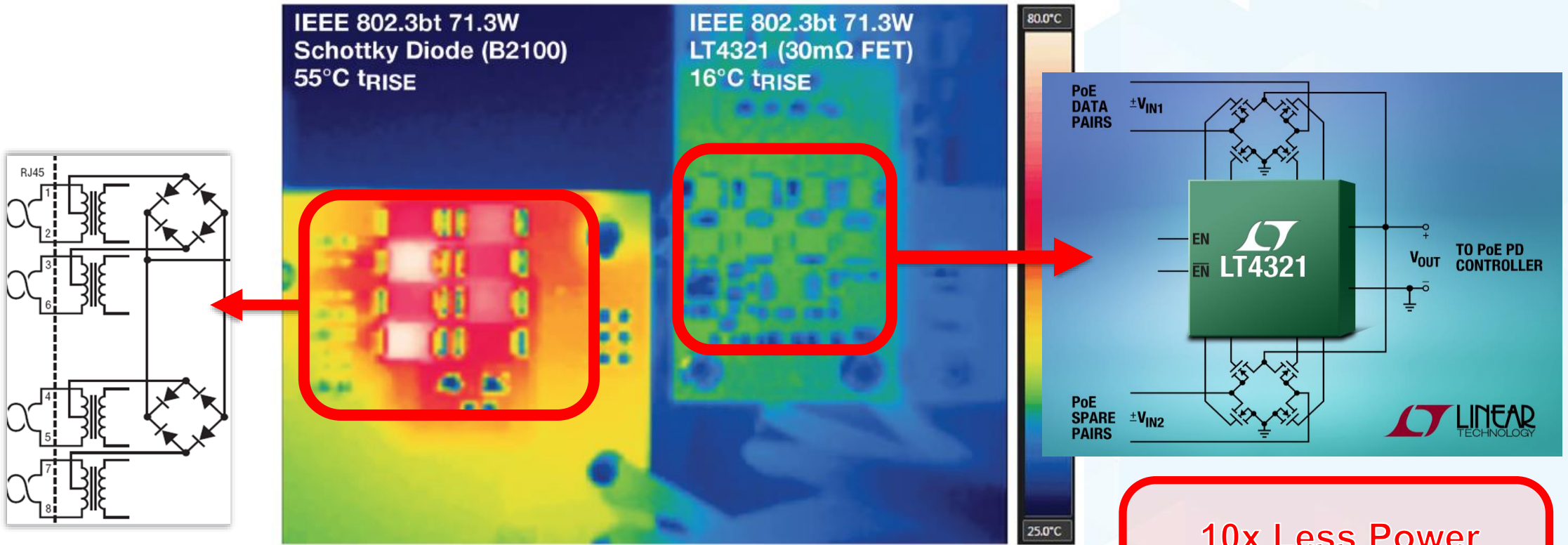
# Isolated Solution w/ MAX5986



# Featured Part: LT4321

## PoE Ideal Diode Bridge

**Ideal Diode  
Bridge**



**10x Less Power  
Loss vs. Standard  
Diode Bridge**



# IEEE Compliance and Certification

## Standards Definition

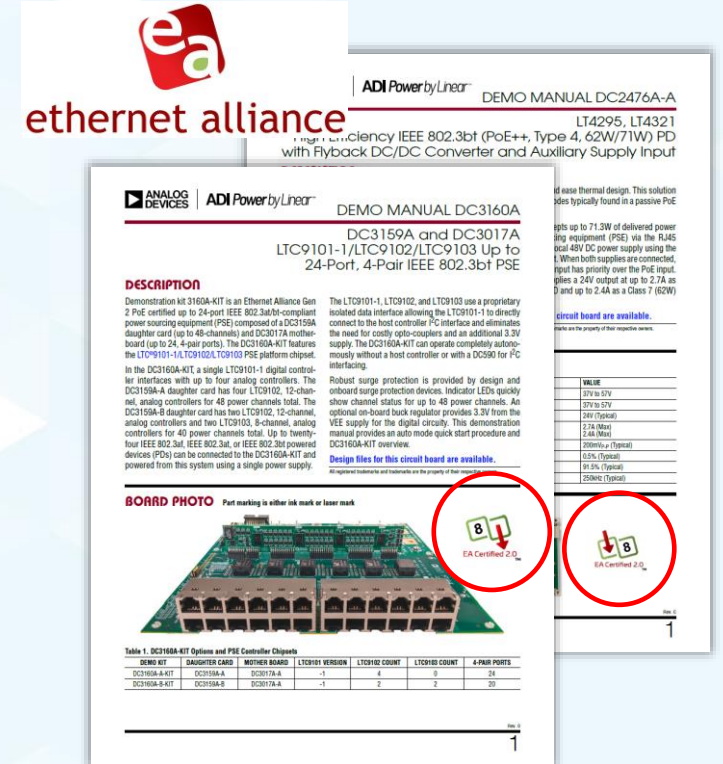
## 3<sup>rd</sup> Party Test/Test Equipment

## PoE Certification



- ▶ ADI maintains close involvement with IEEE committee PoE standards

- ▶ ADI tests its solutions with 3<sup>rd</sup> party Sifos and REACH PoE test equipment
- ▶ ADI takes part in PoE plugfest events at UNH IoL



- ▶ 25 PoE certified ADI EVAL boards

# ADI's Advanced Applications Support

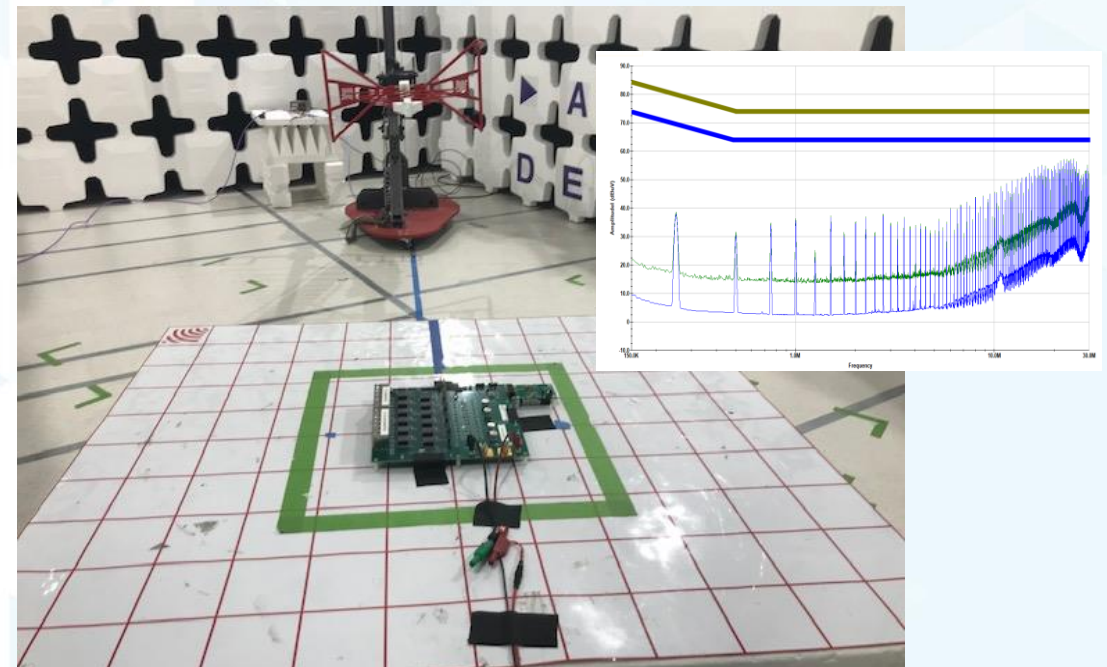
## ► Surge

- In-house testing capability
  - 1.2μs/50μs and 10μs/700μs, up to 6.6kV
- ADI EVAL boards tested to IEC61000-4-5
- ADI provides surge robust solutions

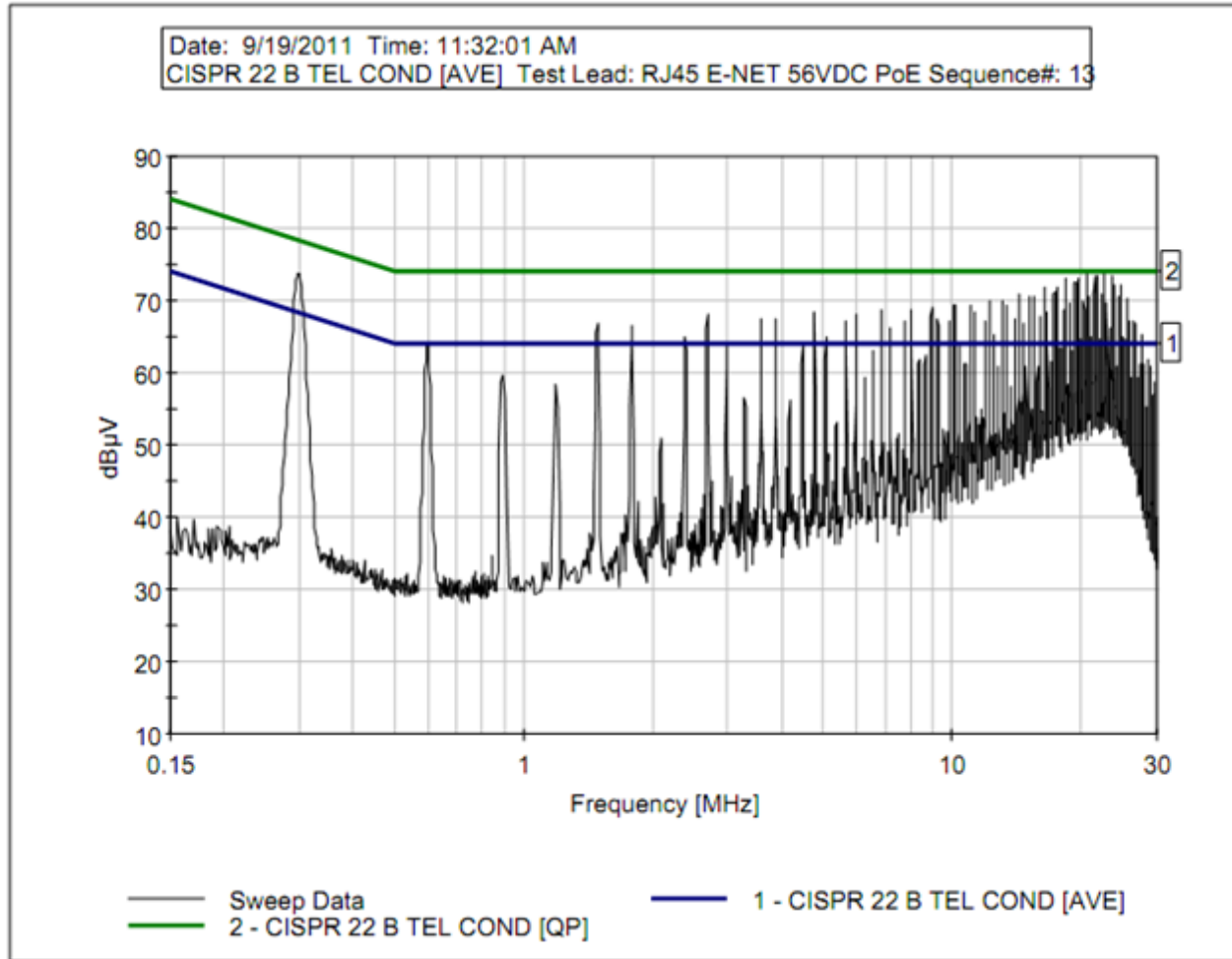


## ► EMI/EMC

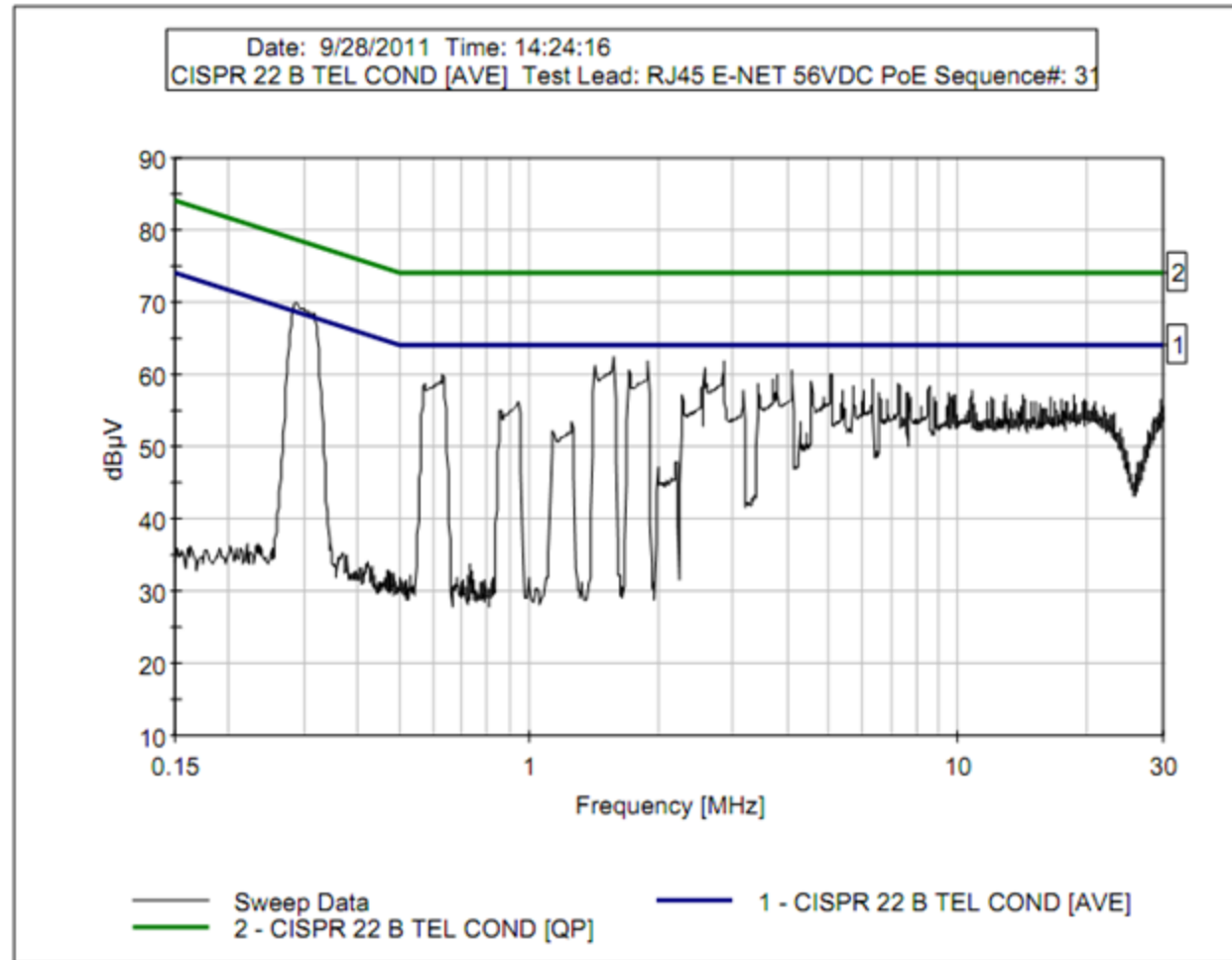
- In-house testing capability
- CISPR32 conducted emissions test results available for ADI EVAL boards



# No Dithering added in MAX5969+MAX5974 PD



# 5% Dithering Added MAX5969+MAX5974 PD





NOW PART OF



*Thank you!*