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# Power Component Design Methodology

## Fast and cost effective ways to power your system

2 December 2015

Salah BEN DOUA–Applications Engineering
Vicor Power Components

## What is the Power Component Design Methodology?

› An approach for engineers to predictably and cost-effectively design high-performance power systems.

› Follows the process of ***identification***, ***architecting*** and ***implementing*** to deliver a power system from the power source to the point of load.

› Vicor provides the power components and tools to enable the designer to build high-performance systems using this methodology.

# A Component Power Approach – Why Use Power Components?

## System Performance

- Your system requires a high performance power system, and designing high-performance power is beyond your expertise
- Power components give you access to high performance

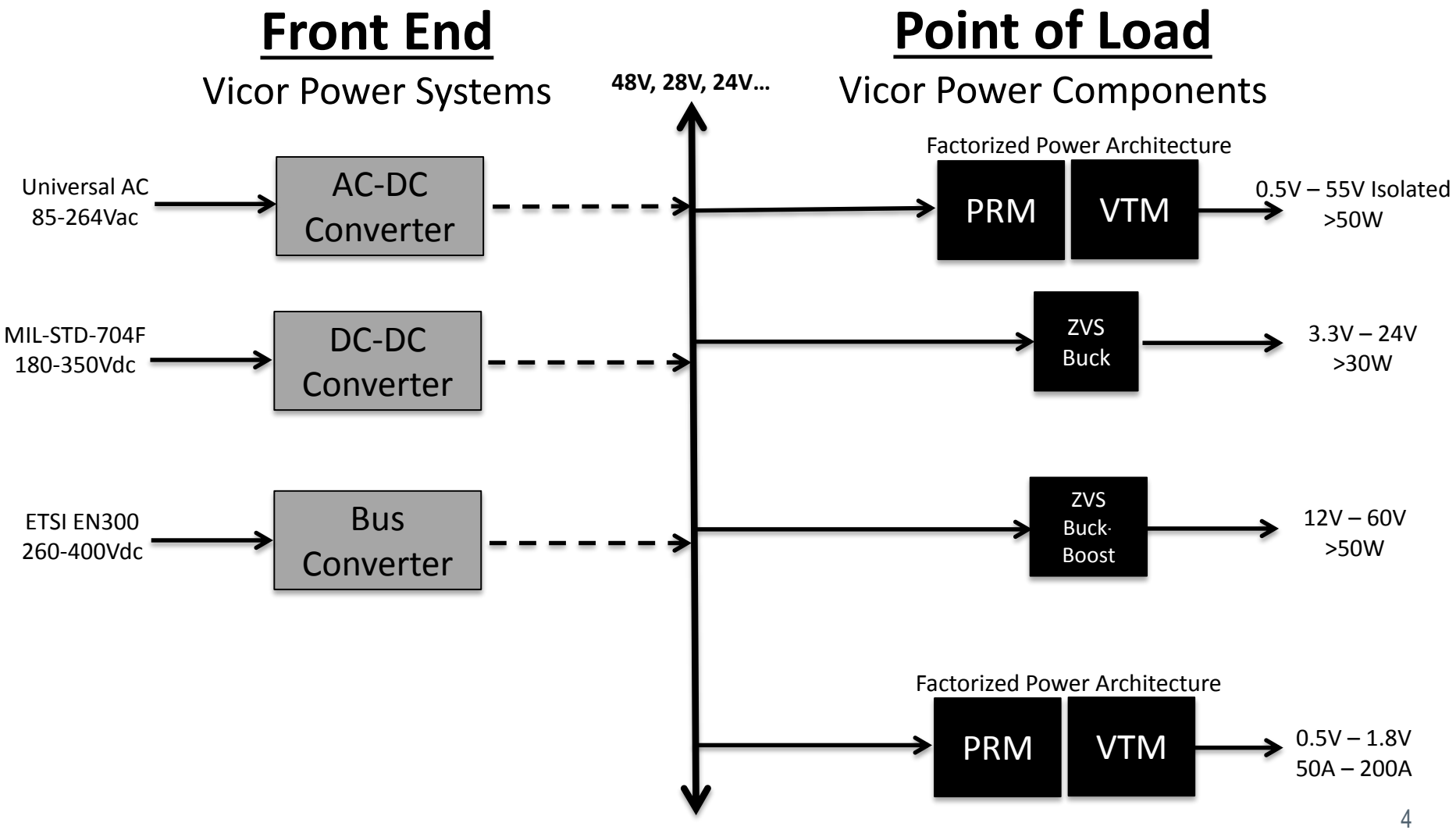
## Flexibility

- Your system needs the ability to re-use designs and customize, scale, or “tweak” each design to the load’s individual needs
- Power components allow the power system to be designed to the exact system requirements and then scaled or modified for other systems

## Design Cycle

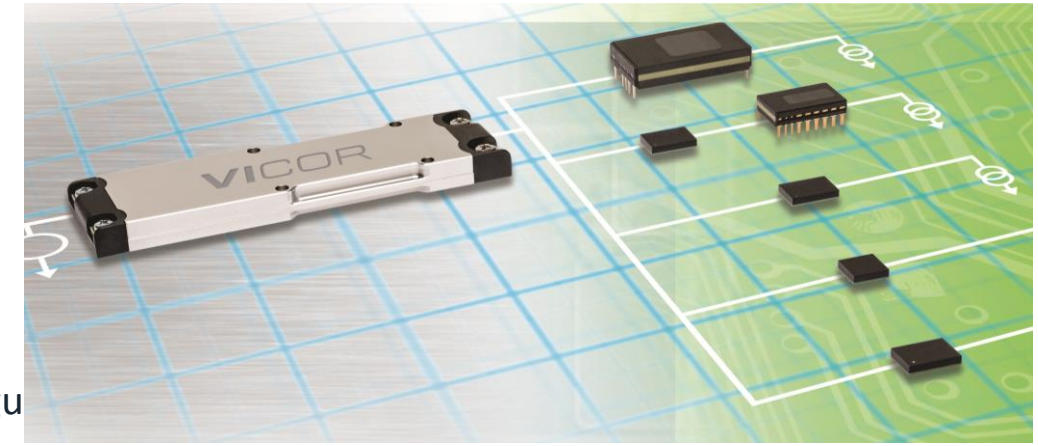
- You need the fastest design cycle possible, or you need to design a system with the least effort, lowest risk, and fewest resources available
- Power components offer a straightforward and easy way for a “non-power expert” engineer to design a power system with the best chance for “first power-up” success

# Power Component Methodology Summary



# Front End Design Considerations

- **Input Source requirements**
  - Operating Range
    - Power requirements over line
  - Voltage Surge/Dropout
    - Clamp vs. survive
    - Shut down vs. Ride through
  - EMI Filtering
  - Fusing/Protection
- **Output Bulk Voltage**
  - Load
    - Battery
    - Negative Impedance (downstream regu
    - Capacitive or pulsed power
  - Regulated vs. Fixed Ratio
  - Tightly regulated vs. loosely regulated
- **Telemetry**
  - Requirements
  - Protocol



# Vicor Power Systems: Front-End Modules

## VIA PFM AC Front End

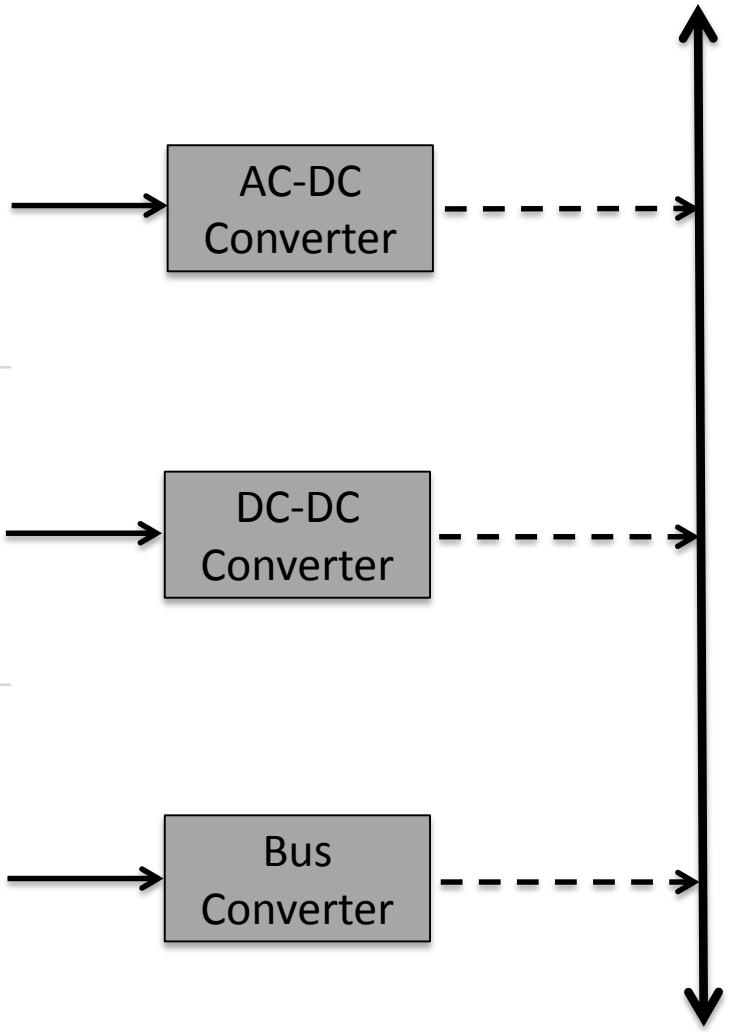
- 85 to 264 $V_{AC-IN}$
- $V_{OUT}$ = 48 V
- Power = 400 W

## DCM Isolated DC-DC Converters

- 300 V and 28 $V_{IN}$ nominal
- $V_{OUT}$ = 48, 28, 24, 13.8, 12 and 5 V
- Power = Up to 600 W per module

## BCM Isolated Fixed Ratio DC-DC Converters

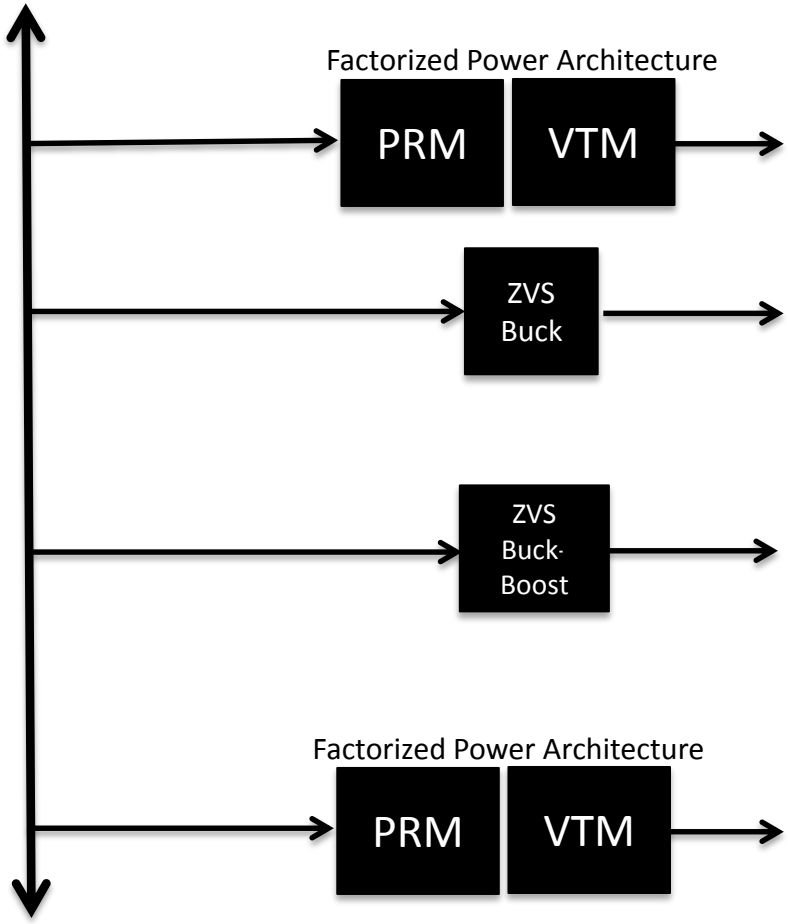
- 400, 380, 350, 270, 48 $V_{IN}$ nominal
- $V_{OUT}$ = 3 to 50 V
- Power = Up to 1.75 kW per module



# Point of Load Design Considerations

- **Input Source**
  - Regulated bus or un-regulated
- **Load**
  - Single voltage setpoint or trimmable
  - Isolated or non-isolated
  - Negative voltage needed?
  - Regulated voltage or regulated current
  - Transient requirements
    - Response time
    - Maximum undershoot/overshoot
  - Load protection requirements
  - Steady state vs. peak power/current requirements
  - Output voltage ripple and noise
  - Startup and sequencing
- **Telemetry**
  - Requirements
  - Protocol


# Vicor Power Components: Point-of-Load Solutions




## Cool-Power ZVS Buck Regulators

- Best-in-class density and efficiency
- 12 V, 24 V and 48 $V_{IN}$ nominal buck regulators
- LGA and ChiP packaged

## Cool-Power ZVS Buck-Boost Regulators

- Over 98% efficiency
- 24 V and 48 $V_{IN}$ nominal buck-buck regulators
- General purpose and VTM compatible versions
- LGA and ChiP packaged

## VI Chip PRM ZVS Buck-Boost Regulators

- Regulated, non-isolated buck-boost operation
- 24, 28, 36, 48 $V_{IN}$
- Up to 98% efficiency
- Up to 250/600 W (parallelable) in half/full VI Chip package

## VI Chip VTM ZVS/ZCS Current Multipliers

- Fixed-ratio solutions for high current delivery
- Used with PRM and ZVS Buck-Boost products for complete regulated DC-DC converter
- VI Chip and ChiP packaged

# Conclusion: Power Component Methodology steps to success

**Identify Requirements**

- Big picture
- What are the system needs?
- What's available?

**Architect a system**

- Power System Designer (today)
- Block diagram

**Implement the design**

- Power System Designer (future)
- The details of a power system
- How are these power components configured?

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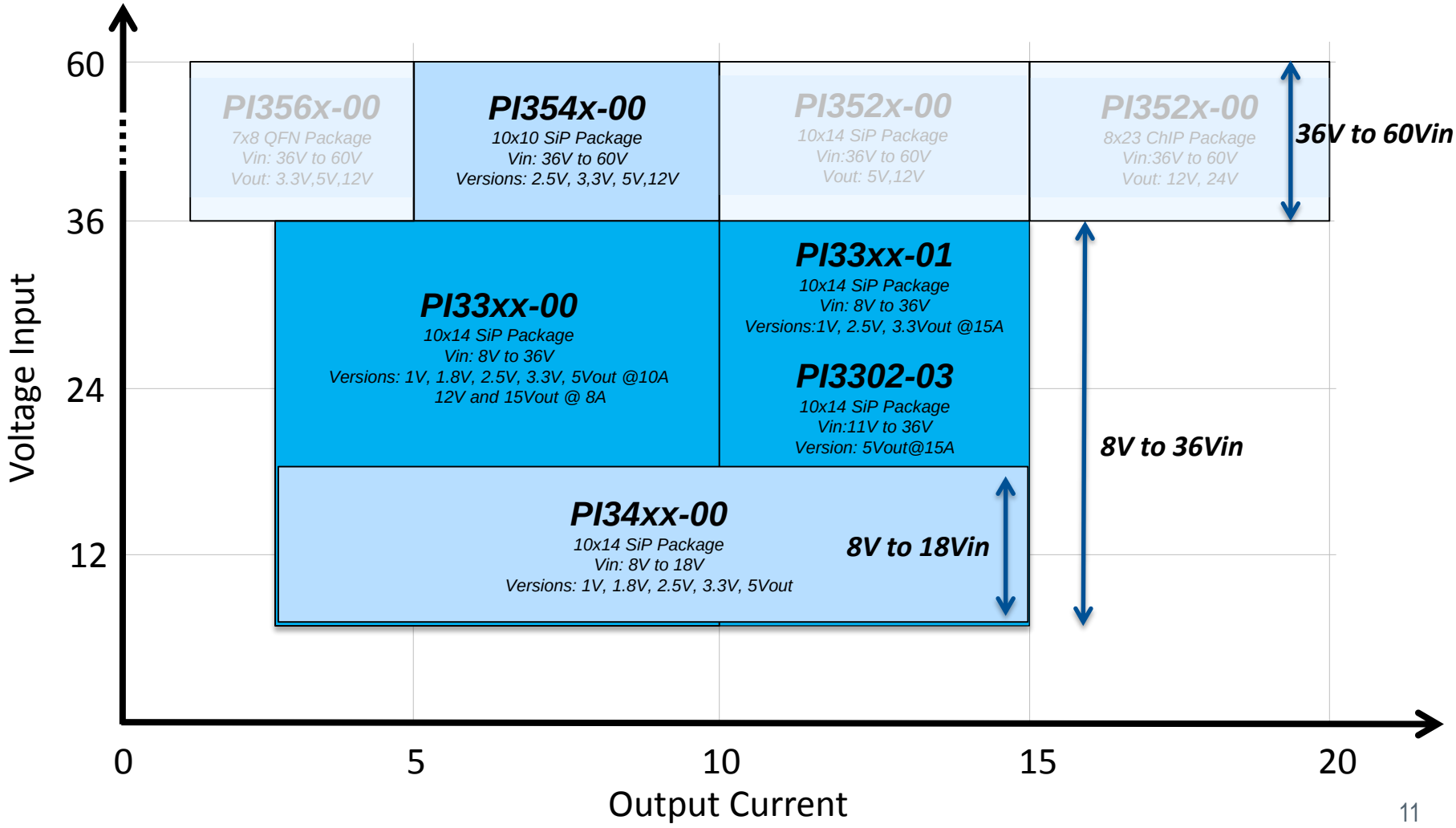
# Cool-Power ZVS Buck Regulator & LED Driver

# Cool-Power ZVS Buck Regulators



| | Cool-Power | Output Range | | Iout Max |
|---|---|---|---|---|
| | | Set | Range | |
| 8 – 18 $V_{IN}$ | **12 V Nominal Versions** | | | |
| | PI3420-00-LGIZ | 1.0 V | 1.0 – 1.4 V | 15 A |
| | PI3421-00-LGIZ | 1.8 V | 1.4 – 2.0 V | 15 A |
| | PI3422-00-LGIZ | 2.5 V | 2.0 – 3.1 V | 15 A |
| | PI3423-00-LGIZ | 3.3 V | 2.3 – 4.1 V | 15 A |
| | PI3424-00-LGIZ | 5.0 V | 3.3 – 6.5 V | 15 A |
| 8 – 36 $V_{IN}$ | **24 V Nominal Versions** | | | |
| | PI3311-00-LGIZ | 1.0 V | 1.0 – 1.4 V | 10 A |
| | PI3318-00-LGIZ | 1.8 V | 1.4 – 2.0 V | 10 A |
| | PI3312-00-LGIZ | 2.5 V | 2.0 – 3.1 V | 10 A |
| | PI3301-00-LGIZ | 3.3 V | 2.3 – 4.1 V | 10 A |
| | PI3302-00-LGIZ | 5.0 V | 3.3 – 6.5 V | 10 A |
| | PI3303-00-LGIZ | 12 V | 6.5 – 13.0 V | 8 A |
| | PI3305-00-LGIZ | 15 V | 10.0 – 16.0 V | 8 A |
| | **24 V Nominal (High Current) Versions** | | | |
| | PI3311-01-LGIZ | 1.0 V | 1.0 –1.4 V | 15 A |
| | PI3318-01-LGIZ | 1.8 V | 1.4 – 2.0 V | 15 A |
| | PI3312-01-LGIZ | 2.5 V | 2.0 – 3.1 V | 15 A |
| | PI3301-01-LGIZ | 3.3 V | 2.3 – 4.1 V | 15 A |
| | PI3302-03-LGIZ** | 5 V | 3.3 – 6.5 V | 15 A |
| | **24 V Nominal I²C* Functionality** | | | |
| | PI3311-20-LGIZ | 1.0 V | 1.0 – 1.4 V | 10 A |
| | PI3318-20-LGIZ | 1.8 V | 1.4 – 2.0 V | 10 A |
| | PI3312-20-LGIZ | 2.5 V | 2.0 – 3.1 V | 10 A |
| | PI3301-20-LGIZ | 3.3 V | 2.3 – 4.1 V | 10 A |
| | PI3302-20-LGIZ | 5.0 V | 3.3 – 6.5 V | 10 A |
| | PI3303-20-LGIZ | 12 V | 6.5 – 13.0 V | 8 A |
| | PI3305-20-LGIZ | 15 V | 10.0 – 16.0 V | 8 A |
| | PI3311-21-LGIZ | 1.0 V | 1.0 – 1.4 V | 15 A |
| | PI3318-21-LGIZ | 1.8 V | 1.4 – 2.0 V | 15 A |
| | PI3312-21-LGIZ | 2.5 V | 2.0 – 3.1 V | 15 A |
| | PI3301-21-LGIZ | 3.3 V | 2.3 – 4.1 V | 15 A |
| 36 – 60 $V_{IN}$ | **48 V Nominal Versions** | | | |
| | PI3542-00-LGIZ | 2.5 V | 2.2 – 3.0 V | 10 A |
| | PI3543-00-LGIZ | 3.3 V | 2.6 – 4.0 V | 10 A |
| | PI3545-00-LGIZ | 5.0 V | 4.0 – 6.5 V | 10 A |
| | PI3546-00-LGIZ | 12.0 V | 6.5 – 14.0 V | 6 A |
| | PI3548-00-LGIZ | 24.0 V | 14.0 – 26.0 V | 6 A |

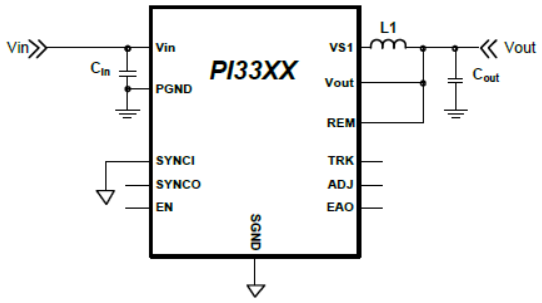
** I²C is a trademark of NXP Semiconductors*

***Input operating range is limited to 11 V to 36 V*

# PI33xx and PI34xx Details

## PoL Cool-Power® ZVS Buck Regulators

- **Regulators are tuned for specific output ranges enabling maximum performance**
- **External inductor used for continued power delivery over-temp (diminishes early temp de-rating)**
- **Power density exceeds that of internal inductor modules (even with the external 8 x 7 x 5 mm inductor)**
- **No additional design requirements (loop compensation, etc.)**




**Cool-Power ZVS-Buck with all required external components for basic operation**

| | Cool-Power | Output Range | | Iout Max |
|---|---|---|---|---|
| | | Set | Range | |
| 8 – 18 $V_{IN}$ | **12 V Nominal Versions** | | | |
| | PI3420-00-LGIZ | 1.0 V | 1.0 – 1.4 V | 15 A |
| | PI3421-00-LGIZ | 1.8 V | 1.4 – 2.0 V | 15 A |
| | PI3422-00-LGIZ | 2.5 V | 2.0 – 3.1 V | 15 A |
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| | PI3424-00-LGIZ | 5.0 V | 3.3 – 6.5 V | 15 A |
| 8 – 36 $V_{IN}$ | **24 V Nominal Versions** | | | |
| | PI3311-00-LGIZ | 1.0 V | 1.0 – 1.4 V | 10 A |
| | PI3318-00-LGIZ | 1.8 V | 1.4 – 2.0 V | 10 A |
| | PI3312-00-LGIZ | 2.5 V | 2.0 – 3.1 V | 10 A |
| | PI3301-00-LGIZ | 3.3 V | 2.3 – 4.1 V | 10 A |
| | PI3302-00-LGIZ | 5.0 V | 3.3 – 6.5 V | 10 A |
| | PI3303-00-LGIZ | 12 V | 6.5 – 13.0 V | 8 A |
| | PI3305-00-LGIZ | 15 V | 10.0 – 16.0 V | 8 A |
| | **24 V Nominal (High Current) Versions** | | | |
| | PI3311-01-LGIZ | 1.0 V | 1.0 –1.4 V | 15 A |
| | PI3318-01-LGIZ | 1.8 V | 1.4 – 2.0 V | 15 A |
| | PI3312-01-LGIZ | 2.5 V | 2.0 – 3.1 V | 15 A |
| | PI3301-01-LGIZ | 3.3 V | 2.3 – 4.1 V | 15 A |
| | PI3302-03-LGIZ** | 5 V | 3.3 – 6.5 V | 15 A |
| | **24 V Nominal I²C* Functionality** | | | |
| | PI3311-20-LGIZ | 1.0 V | 1.0 – 1.4 V | 10 A |
| | PI3318-20-LGIZ | 1.8 V | 1.4 – 2.0 V | 10 A |
| | PI3312-20-LGIZ | 2.5 V | 2.0 – 3.1 V | 10 A |
| | PI3301-20-LGIZ | 3.3 V | 2.3 – 4.1 V | 10 A |
| | PI3302-20-LGIZ | 5.0 V | 3.3 – 6.5 V | 10 A |
| | PI3303-20-LGIZ | 12 V | 6.5 – 13.0 V | 8 A |
| | PI3305-20-LGIZ | 15 V | 10.0 – 16.0 V | 8 A |
| | PI3311-21-LGIZ | 1.0 V | 1.0 – 1.4 V | 15 A |
| | PI3318-21-LGIZ | 1.8 V | 1.4 – 2.0 V | 15 A |
| | PI3312-21-LGIZ | 2.5 V | 2.0 – 3.1 V | 15 A |
| | PI3301-21-LGIZ | 3.3 V | 2.3 – 4.1 V | 15 A |
| 36 – 60 $V_{IN}$ | **48 V Nominal Versions** | | | |
| | PI3542-00-LGIZ | 2.5 V | 2.2 – 3.0 V | 10 A |
| | PI3543-00-LGIZ | 3.3 V | 2.6 – 4.0 V | 10 A |
| | PI3545-00-LGIZ | 5.0 V | 4.0 – 6.5 V | 10 A |
| | PI3546-00-LGIZ | 12.0 V | 6.5 – 14.0 V | 6 A |
| | PI3548-00-LGIZ | 24.0 V | 14.0 – 26.0 V | 6 A |

** I²C is a trademark of NXP Semiconductors*

***Input operating range is limited to 11 V to 36 V*

# PI33xx and PI34xx Details

## PoL Cool-Power® ZVS Buck Regulators

› **Wide Operating Range: -40°C to 125°C**

› **High Efficiency**
- >98% peak 19 $V_{IN}$ to 15 $V_{OUT}$
- >95% peak 36 $V_{IN}$ to 12 $V_{OUT}$
- >95% peak 24 $V_{IN}$ to 12 $V_{OUT}$
- >95% peak 12 $V_{IN}$ to 5 $V_{OUT}$
- PI34xx series optimized for 12 $V_{IN}$ with even higher efficiency

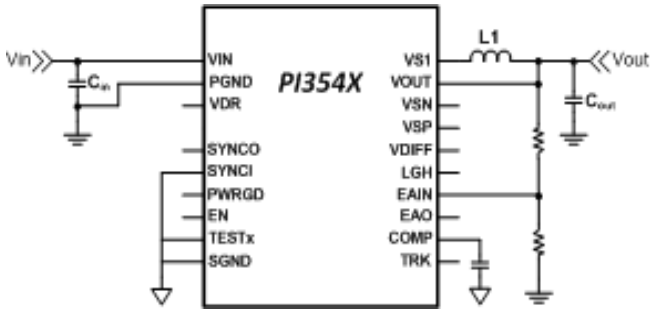
› **Flexible and Rich Feature Set**
- Paralleling and single wire current sharing
- Frequency synchronization
- User adjustable soft-start & tracking

› **Optional I²C Functionality & Programmability**
- $V_{OUT}$ margining
- Fault reporting
- ENABLE and SYNCI pin polarity
- Phase delay (for interleaving multiple regulators)

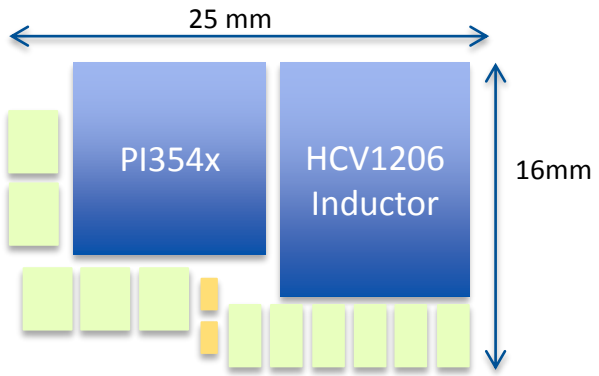
# PI354x Cool-Power ZVS Buck Regulators

## Nothing Simpler.

- **Industry leading efficiency and power density**
- **No design necessary for basic operation**
- **Internal compensation**
  - Reduces external parts count
- **Inductor design and selection already complete**
  - Utilizes HCV1206 or FPT1006 Series Inductors from Eaton
- **Paralleling bucks just as easy**
  - Simple current sharing + interleaved by default
- **Optional constant current output for LED lighting or battery charging**



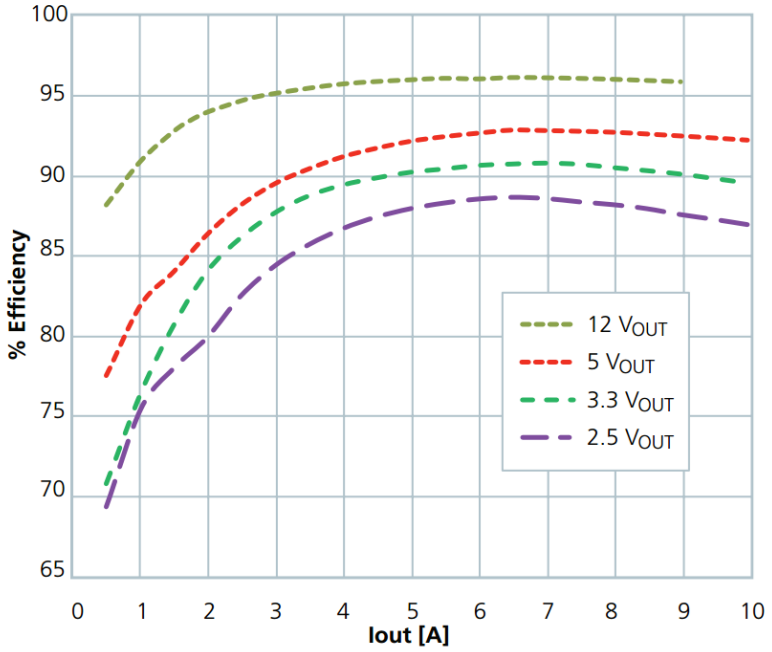

***Minimal External Components for Basic Buck Regulator Operation***




***Devices shown relative in size to each other (may not represent final layout)***

# PI354x Series

## 48Vin Optimized ZVS Buck Regulator & LED Driver




*PI35 efficiency performance from 48Vin*

- Wide input voltage range of 36V to 60V
- Constant voltage or constant current operation
- Parallel capable with single wire current sharing
- Input Over/Under Voltage Lockout (OVLO/UVLO)
- Output Overvoltage Protection (OVP)
- Over Temperature Protection (OTP)
- Differential amplifier for output remote sensing
- Wide -40°C to 125°C operating range

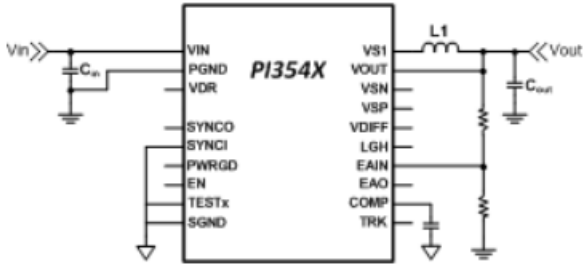
| Device | Output Voltage | | $I_{OUT}$ Max |
|---|---|---|---|
| | Set | Range | |
| PI3542-00-LGIZ | 2.5 V | 2.2 V to 3.0 V | 10 A |
| PI3543-00-LGIZ | 3.3 V | 2.6 V to 3.6 V | 10 A |
| PI3545-00-LGIZ | 5.0 V | 4.0 V to 5.5 V | 10 A |
| PI3546-00-LGIZ | 12 V | 6.5 V to 14 V | 9 A |

*PI35 Portfolio*

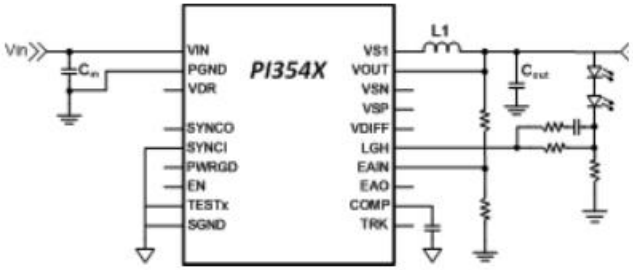
# Constant Current Regulation Output Feature

**Primary applications:**

- LED lighting
- Battery / super-capacitor charging
- High peak current pulse transient load applications




*Typical PI354x Voltage Regulator application (Constant Voltage Output)*




*Typical PI354x Voltage Regulator LED lighting application (Constant Current Output)*

# Applications

## Leveraging High Voltage Conversion

- **Eliminating $I^2R$ losses**
  - 15W delivered by 12V via 1ohm loss in resistance = $(1.25A)^2$*1ohm = 1.563W loss
  - 15W delivered by 48V via 1ohm loss in resistance = $(0.31A)^2$*1ohm = 0.098W loss
  - ***15X in power loss reduction***

- **Eliminating intermediate conversion stages**
  - 48 V -> 12 V and 12 V -> 3.3 V stages combine to a single ZVS Buck stage

- **Higher Power thru parallel operation**
  - Two ZVS Bucks can be paralleled with single wire current sharing
  - Bucks switch out of phase to each other reducing overall ripple

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# LED Display Design-in Examples

# LED Display Design-in for Information Display Panels

| | |
|---|---|
| **Market** | Industrial |
| **Application** | LED display for passenger bus |
| **Products** | Picor non-isolated ZVS buck regulators |
| **Competition** | Emerson |
| **Power Supply Specifications** | |
| **Input** | 9 – 36 $V_{DC}$ |
| **Bus/Vehicle** | 28 $V_{DC}$ |
| **Outputs** | 4 V at 5 A typically |
| **Loads** | LEDs |


## Why We Won

- High efficiency
- Lower cost than the competitor
- Applications and factory engineering support

## Application Background

This customer designs and manufactures LED based signage and passenger communication systems for the mass transit industry. They are re-designing their product to reduce overall cost and need a higher efficiency, with lower temperature rise, buck regulator that is lower cost than their existing solution.

## Challenges

The output inductor of the PI3301 and the SiP are fitted to the back side of the board to the LEDs. There are three ZVS buck regulators per 64 × 64 pixel panel (one for each primary color). At 5A load the peak temperature of the output inductor resulted in a marginally high temperature on those LEDs directly on the back side of the PCB. If LED temperatures rise too high they can cause noticeable color shifts and will also reduce operating life. Picor engineering was able to recommend using the PI3303-03-LGIZ inductor instead of the standard part. This increased the system efficiency and combined with the slight increase in size, lowered the inductor temperature. They also had some concerns about input conducted EMI, however, a small input inductor was able to resolve this issue.

## Solution

The solution used one PI3301-01-LGIZ with a FP1507R1-R185 inductor per LED display panel. Depending on the length of the display, one, four or eight panels are assembled into the final housing.

# LED Display Design-in for Information Display Panels

| | |
|---|---|
| **Market** | Industrial |
| **Application** | Vehicle-mounted LED advertising display |
| **Products** | ZVS buck regulators |
| **Competition** | Recom, Linear Tech |
| **Power Supply Specifications** | |
| **Input** | 8 – 18 VDC |
| **Outputs** | 5 V at 50 A (can be 2x 25 A) |
| **Load** | LED tiles |


### Why We Won

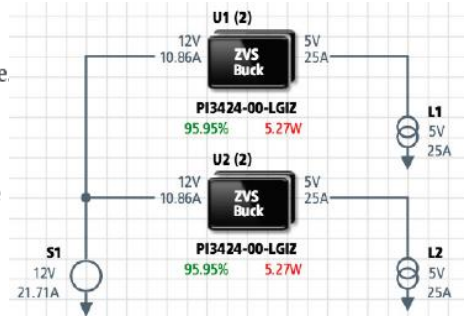
- Ease of use: Simple current sharing and interleaving to reduce EMI
- Thermal Performance
- 3x lower cost of competition
- Adjustable soft-start to deal with inrush from bulk capacitance

### Application Background

This customer is a leader in real-time digital moving media. Using dual-sided screens on the rooftops of Taxis, they were the first regulator-approved service of its kind on the road. With built-in intelligence triggers, they target relevant messages to the right audiences, at the right time.

### Challenges

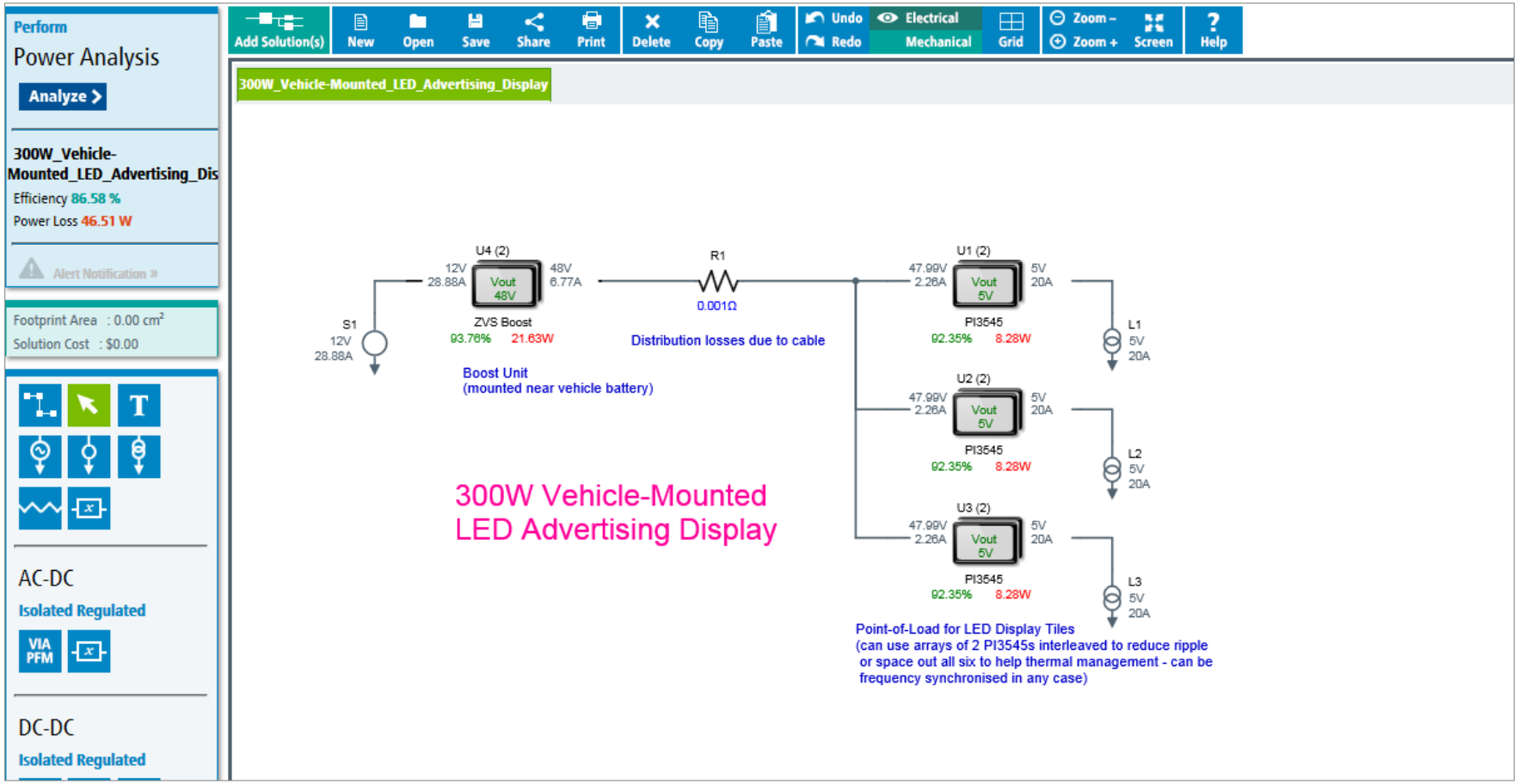
A problem with their existing design was highlighted during field testing in an extremely warm climate. In the mid-day heat, the displays were failing as the power supplies could not cope with the high ambient temperatures. They had looked at a 12-phase buck solution from LTC, requiring 12 converters in parallel with a 13th component, a clock generator IC to set the interleaving clock phases. This also required a costly precision resistor to enable spread-spectrum feature for EMI reduction. Another issue was that they had to run four converters per clock phase open-loop, so it would not be obvious if one had failed, putting the others under greater stress.




### Solution

Two pairs of PI3424s were used to provide current sharing and interleaving 25 A supplies for the LED tiles. The load is immediately applied and there is a large amount of bulk capacitance on the LED tiles, so this sometimes caused the PI3424 to go into current limit and initiate a start-up cycle a number of times. This was easily solved by increasing the soft-start capacitance value to lengthen the soft-start time.

# Alternative LED Display Design-in for Information Display Panels



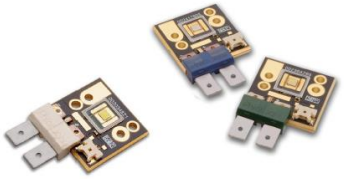
# LED Display Design-in with PI354x 48Vin Bucks

- **Background:** This customer builds large LED displays that cover the sides of buildings. The customer began by using 24Vin bucks to power LED drivers, and they wanted to switch to 48Vin bucks as soon as those parts were available.
- **Why we won:** The customer realized that using 48Vin bucks provided him with efficiency, size and cost advantages. By using a 48V device they were able to eliminate an isolated brick.
- **Challenges for the customer:** Each project and power requirement is different for this kind of business, and the scale of these projects is so large that there is great pressure to make sure that the design works correctly.
- **Our advantage**: Since the 48Vin parts are very similar to the 24Vin bucks, which the customer had been using, he had a high comfort level migrating to 48V, and by doing so he was able to upgrade his system, which gives him an advantage over his competition.

# High Current LEDs – Requiring 9A or more

LUMINUS CBT-90 Product Datasheet

## CBT-90 LEDs



### Table of Contents



### Features:

- Extremely high optical output:
  Over 2,250 White Lumens
  Over 1,800 Green lumens
  Over 650 Blue Lumens
- High thermal conductivity package - junction to heat sink thermal resistance of only 0.92°C/W
- Large, monolithic chip with uniform emitting area of 9 mm²
- Unencapsulated die with low profile protective window optimizes optical coupling in etendue-limited applications
- Lumen maintenance of greater than 70% after 60,000 hours
- Environmentally friendly: RoHS and Halogen compliant

### Applications

- Fiber-coupled Illumination
- Architectural and Entertainment Lighting
- Medical Lighting
- Machine Vision
- Microscopy
- Displays and Signage
- General Illumination
- Spot Lighting
- Emergency Vehicle Lighting
- Projection Systems

LUMINUS CBT-90 Product Datasheet

### CBT-90 White Electrical Characteristics[1]

Optical and Electrical Characteristics ($T_j$ = 70 °C)

| Drive Condition[2] | | | 9.0 A Continuous | |
|---|---|---|---|---|
| Parameter | | Symbol | Values at Test Currents | Unit |
| Current Density | | j | 1.0 | A/mm² |
| Forward Voltage | | $V_{F,min}$ | 2.9 | V |
| | | $V_{F,typ}$ | 3.3 | V |
| | | $V_{F,max}$ | 3.8 | V |

Common Characteristics

| Parameter | Symbol | Values | Unit |
|---|---|---|---|
| Emitting Area | | 9.0 | mm² |
| Emitting Area Dimensions | | 3 x 3 | mm×mm |
| Color Temperature[3] | CCT | 6,500 | K |
| Color Rendering Index[4] (Typical) | $R_a$ | 72 | |
| Forward Voltage Temperature Coefficient[5] | | -5.47 | mV/°C |

Absolute Maximum Ratings

| Parameter | Symbol | Values | Unit |
|---|---|---|---|
| Maximum Current[6] | | 18 | A |
| Maximum Junction Temperature[7] | $T_{j-max}$ | 150 | °C |
| Storage Temperature Range | | -40/+100 | °C |

*Note 1:* *All measured values are with a constant heat sink temperature $T_{heat\ sinks}$ = 40°C.*

*Note 2:* *CBT-90 white devices can be driven at currents ranging from 1A to 18A and at duty cycles ranging from 1% to 100%. Drive current and duty cycle should be adjusted as necessary to maintain the junction temperature desired to meet application lifetime requirements.*

*Note 3:* *CCT value based off of CIE measurement. CIE measurement uncertainty for white devices is estimated to be +/- 0.01.*

*Note 4:* *Color Rendering Index (CRI) is measured to within + or - 2.*

*Note 5:* *Forward voltage temperature coefficient at current density of 1.0 A/mm². Contact Luminus for value at other drive conditions.*

*Note 6:* *CBT-90 White LEDs are designed for operation to an absolute maximum forward drive current density of 2.0 A/mm². Product lifetime data is specified at recommended forward drive currents.*

*Note 7:* *Lifetime dependent on LED junction temperature. Input power and thermal system must be properly managed to ensure lifetime. See charts on pg 8 for further information.*

*Note 8:* *Special design considerations must be observed for operation under 1 A. Please contact Luminus for further information.*



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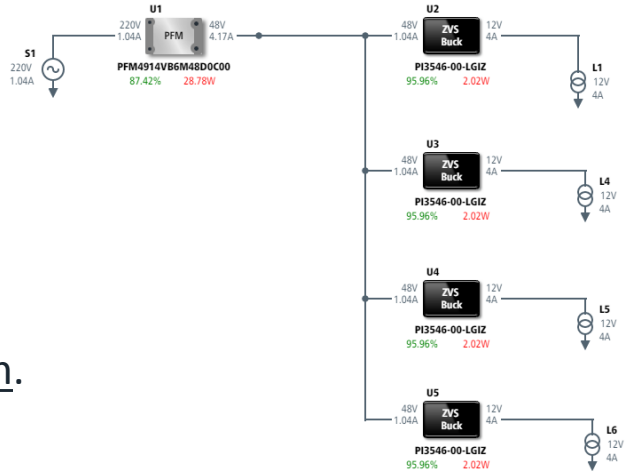
# Architectural LED

- **Application**
  - Static and Dynamic lighting assemblies
  - 24/7/365 Operating Schedule
- **Solution**
  - PFM driving ZVS Bucks & AUX rails
- **Why Vicor Wins**
  - Small size and light weight
  - Cool Factor
- **Power Messaging**
  - People want to see the lights, not the power supply
  - Climbing on building is dangerous;  more time spent during installation means more time for an accident.
  - Vicor's products result in a faster and easier installation.

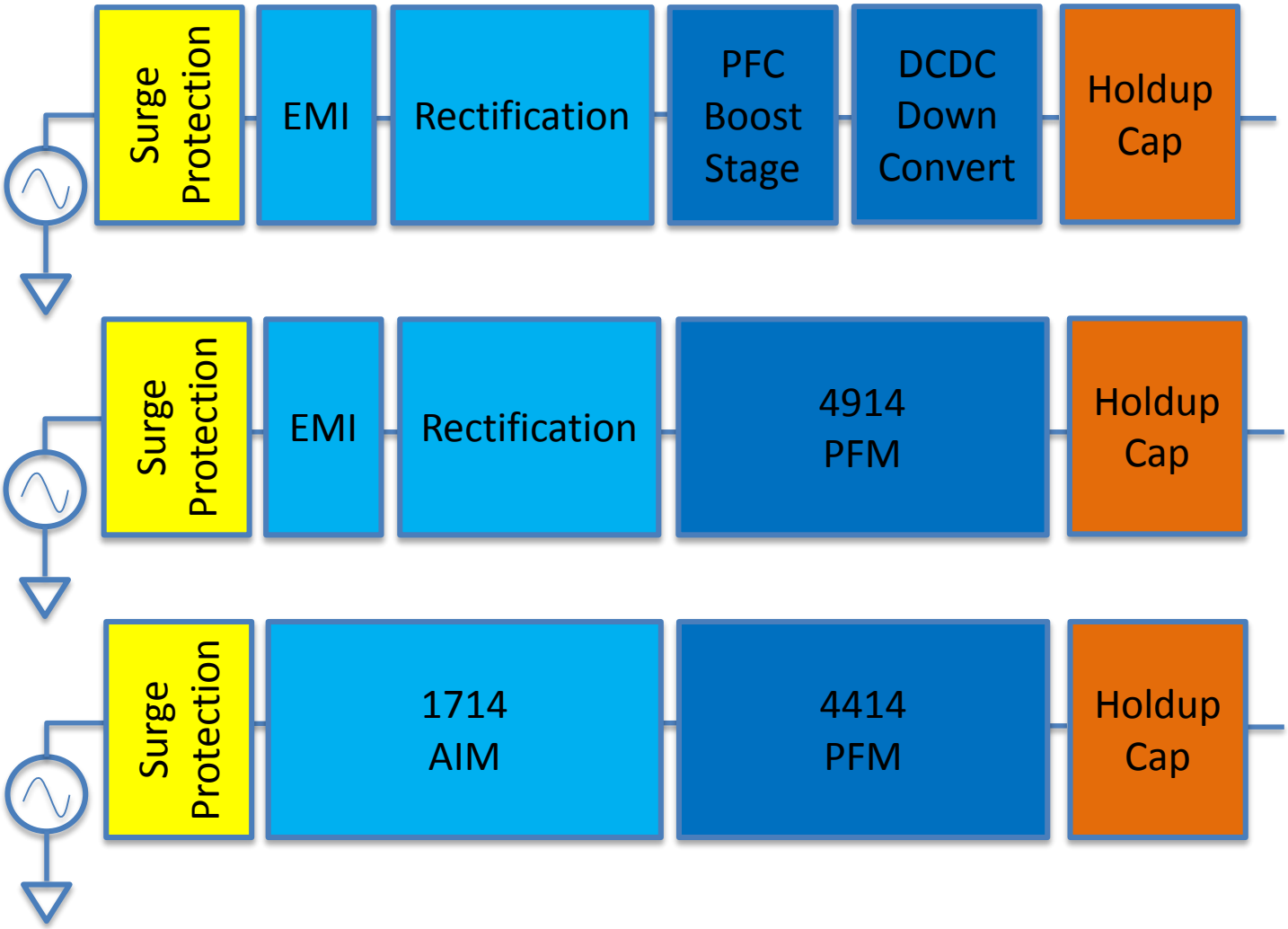


# PFM & AIM : Key component in AC-DC power system

- **The PFM is an isolated, regulated converter in a VIA package**
  - Input : Rectified single phase AC
  - Output : regulated 24 or 48 Volts
  - Chassis or board mount, C & T grades
  - Up to 400 W
  - No paralleling (no innate share ability)
- **The AIM is filtering & rectification in a VIA package**
  - Input : Single Phase AC
  - Output : Rectified single phase AC
- **Future Options**
  - 200 W
  - Analog & Digital (PMBus) Control
- **The AIM + PFM meet required safety and radiated/conducted EMI standards**
  - Class B per EN55022
  - External TMOV required for EN61000-4-5 compliance for surge immunity


| Product | Tested w/AIM ? | $V_{OUT}$ | EN55022 | Release to Production |
|---|---|---|---|---|
| PFM4914 | NO | 48 | Class A | NOW |
| PFM4914 | NO | 24 | Class A | NOW |
| AIM1714 & PFM4414 | YES | 48 | Class B | November 18th |
| AIM1714 & PFM4414 | YES | 24 | Class B | November 25th |

# 4914 vs. 4414 : Different level of integration




› **Typical AC-DC**

› **With 4914**

› **With AIM + 4414**

# PFM Demo boards → "Component Methodology Kit"

- **Shipping to TSCs this December**
- **Front End**
  - AIM + PFM
  - Holdup Cap included
- **PoL**
  - ZVS Bucks
- **More product options in development**