

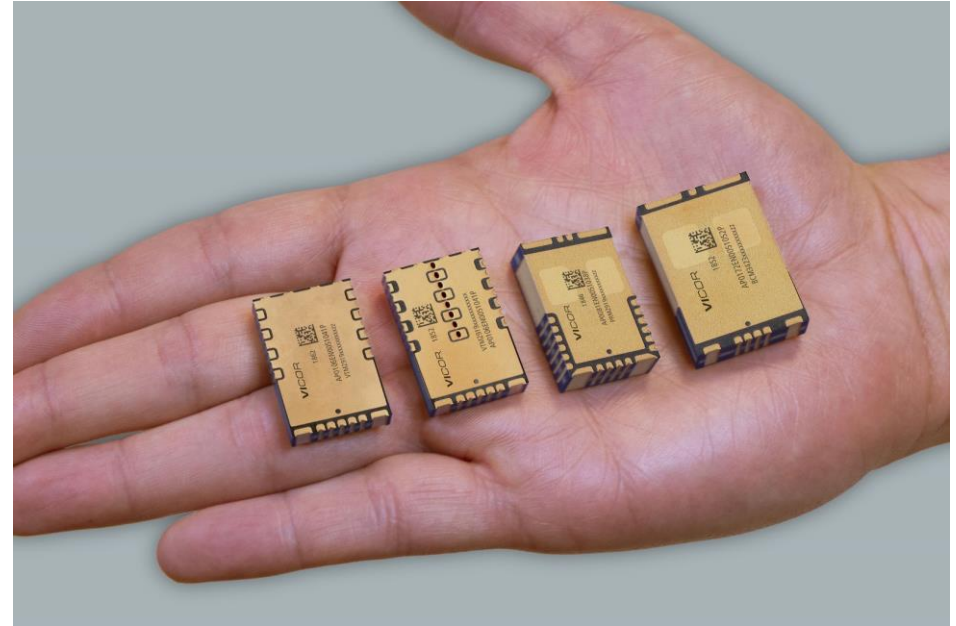
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Vicor introduces Power Module Design Methodology for Space Applications

April 19-22, 2021

Outline

- Factorized Power Commercial Applications
- FPA Solutions for New Space
- Radiation Tolerant Power Modules 
- Modular Power Solutions Examples



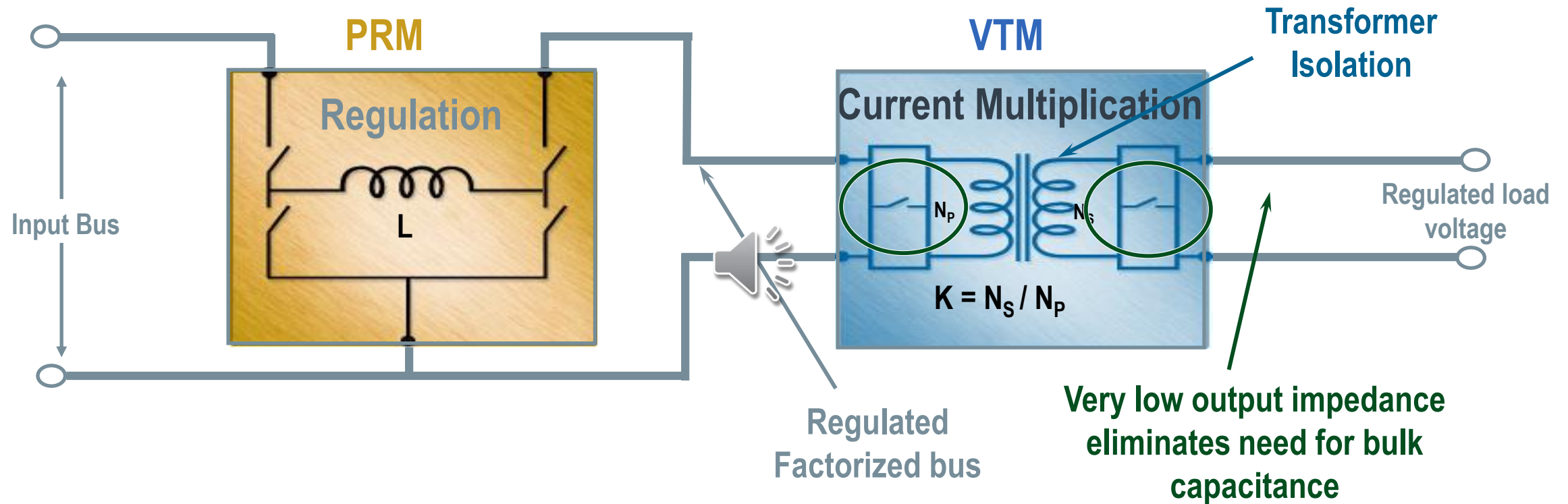
Powering High Performance Communication ASICs.

Modules shown deliver 0.8V @ 150A and 3.3V at 50A ...from a 100V bus!

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Vicor Commercial Factorized Power

Factorized Power Architecture – Regulation separated from transformation and isolation



Efficiently distributes, regulates, transforms and isolates power.

FPA Advantages in commercial applications

- High current delivery capacity >500A
- Fast transient response
- Reduced real estate consumption near the FPGA/ASIC/GPU
- Lowers PDN losses and impedances
- Reduction in output bulk capacitance saves board space
- Low noise coupling to SerDes and other sensitive circuits
- Utilize soft switching topologies
 - Low noise
 - High switching frequency
 - High power density
 - High efficiency
- Modular power solutions are easy to design with



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Vicor Power Solutions for New Space

The Challenge- Powering Digital Payload High-throughput Satellites

- Software defined radio and beamforming place high demands on digital processing FPGAs, ASICs or GPUs
- Processor cores need sub 1V at 10's to 100+ amps
- Power conversion and distribution challenges
- The power supply is exposed to TID and heavy ion radiation
 - Survivability
 - Reliability
- Power systems design is a specialty engineering challenge consuming resources

Total Ionizing Dose Challenge

- Commercial FETs have been selected lot screened for TID
 - Suitable power FETs have significant shift in V_{th} with TID
 - The radiation tolerant modules employ compound FET structures to extend the TID tolerance
- Vicor control IC families are selected for TID tolerance
 - Minor mitigations are added to compensate for some TID shift
- Modules function after 50k TID exposure

SEE Survivability

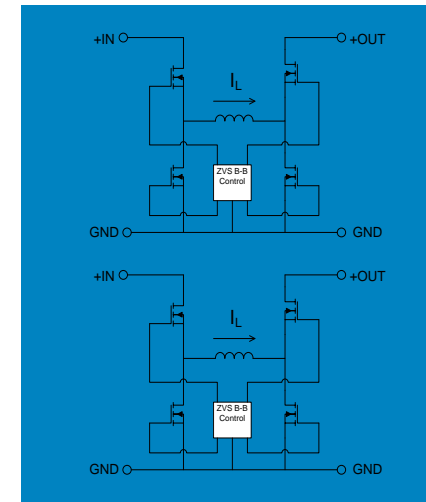
- Commercial MOSFETs have been selected and lot screened for SEB and SEGR
 - Power MOSFETs were selected from robust designs
 - In addition, power MOSFETs are highly derated VDS for survivability
- Control ICs have been screened for SEL, SEFI
 - Mitigation circuits are added to detect over currents and reset to ensure survival

SEFI Mitigation

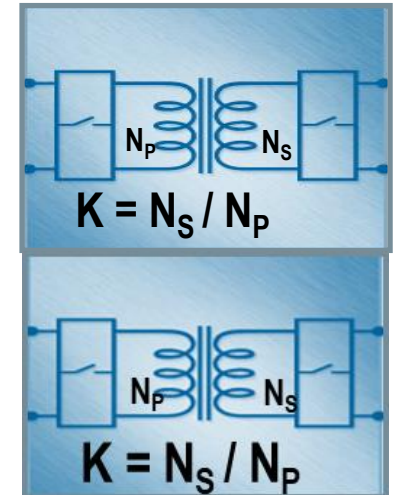
- All radiation tolerant modules include completely redundant power trains operating in parallel
- If one power train gets upset due to a single event, its protection circuits force a reset
- During the reset interval the redundant power train carries the full load
- After the reset, both power trains operate in parallel again

Rad Tolerant

PRM



VTM



Radiation tolerant FPA solution summary

- Radiation tolerance
 - Single Event Effect Immunity:
 - Robust component selections
 - Extreme derating of MOSFETs
 - Latch detection and reset circuitry
 - Redundant parallel architecture for reliable power delivery
 - Total Ionizing Dose: Components tested to 50k rad
 - All active components separately tested to 50k rad
- The modular approach allows for fast radiation tolerant power solution development

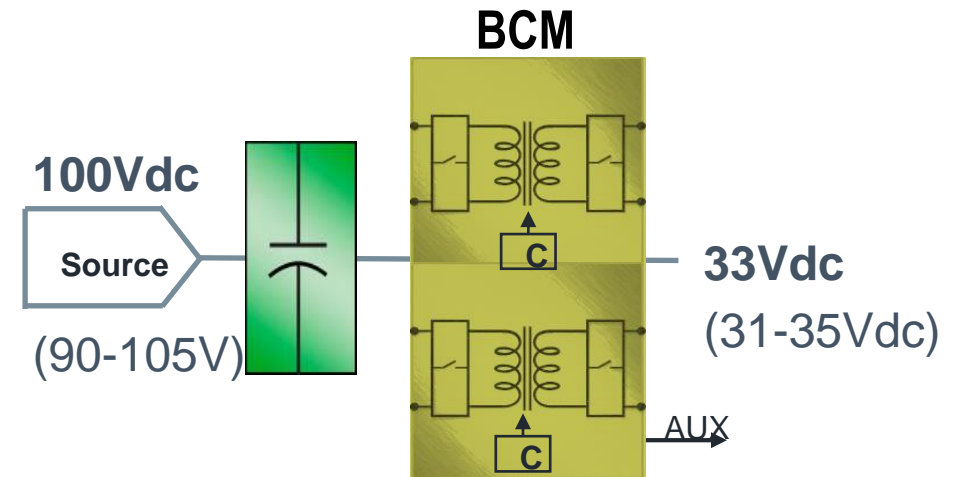


Rad Tolerant Power Modules

100V Fixed Ratio Converter

BCM3423

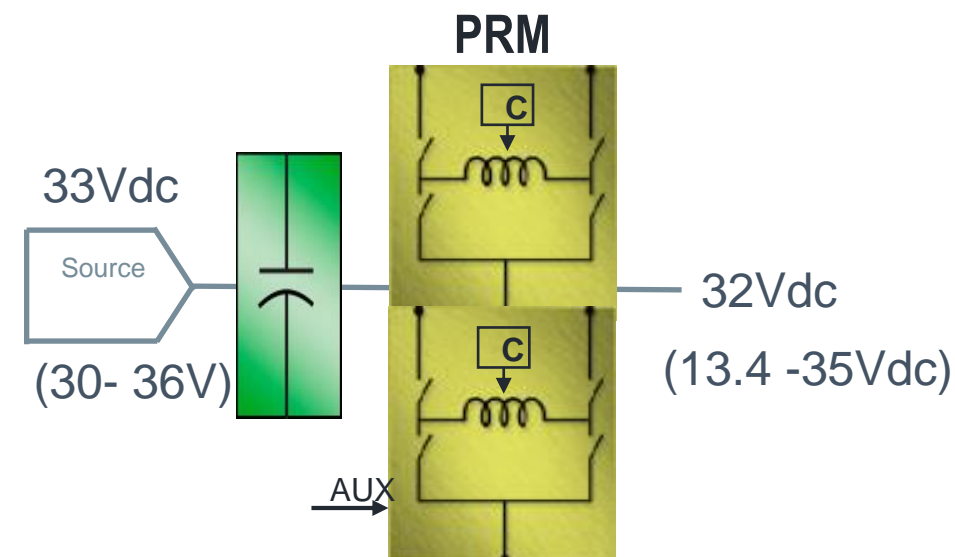
- $V_{in} = 100V_{dc}$ (94-105V and 120V transient)
- $V_{out} = 33V$ (31-35Vdc, $K=1/3$)
- $P_{out} = 300W$
- High efficiency (>94%) reduces system power consumption
- High power density, Low Weight
 - 34x23x8mm, 26g
- Contains built-in protection features against:
 - Undervoltage
 - Overvoltage
 - Overcurrent
 - Short Circuit
 - Overtemperature
- Provides enable/disable control
- ZVS/ZCS Resonant Sine Amplitude Converter topology



33V Regulator

PRM2919

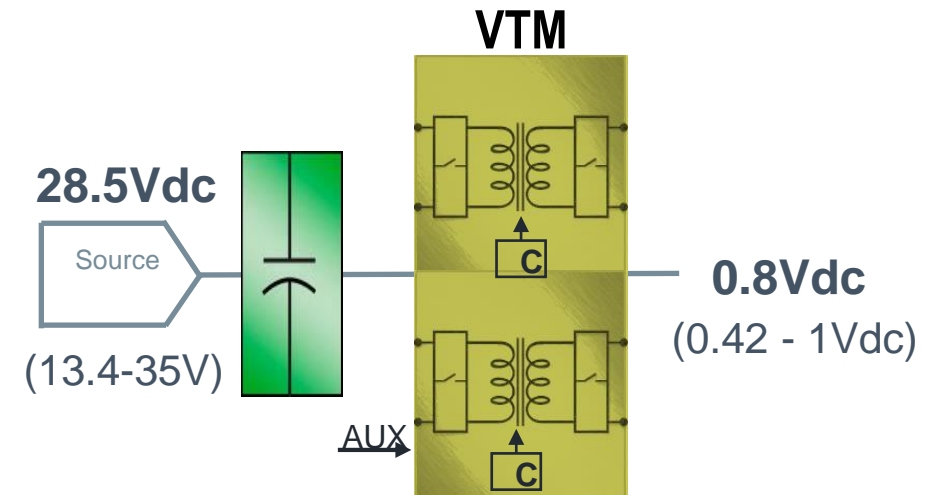
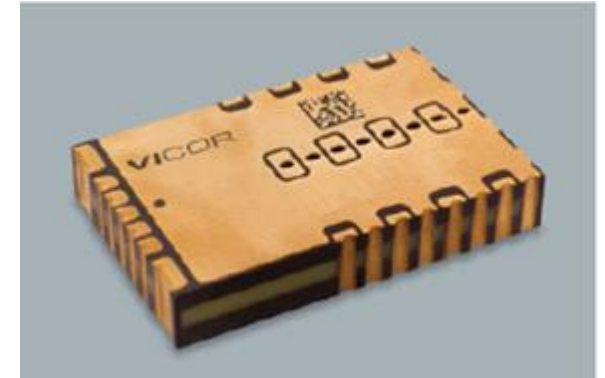
- $V_{in}=33V$ (30-36Vdc)
- $V_{out} = 28V$ (13.4-35Vdc)
- $P_{out} = 200W$
- Full Load efficiency (96%), reduces system power consumption
- High power density, Low Weight
 - 29x19x8mm, 16g
- Contains built-in protection features against:
 - Undervoltage
 - Overvoltage
 - Overcurrent
 - Short Circuit
 - Overtemperature
- Non-isolated ZVS buck-boost regulator topology



150A Current Multiplier

VTM2919

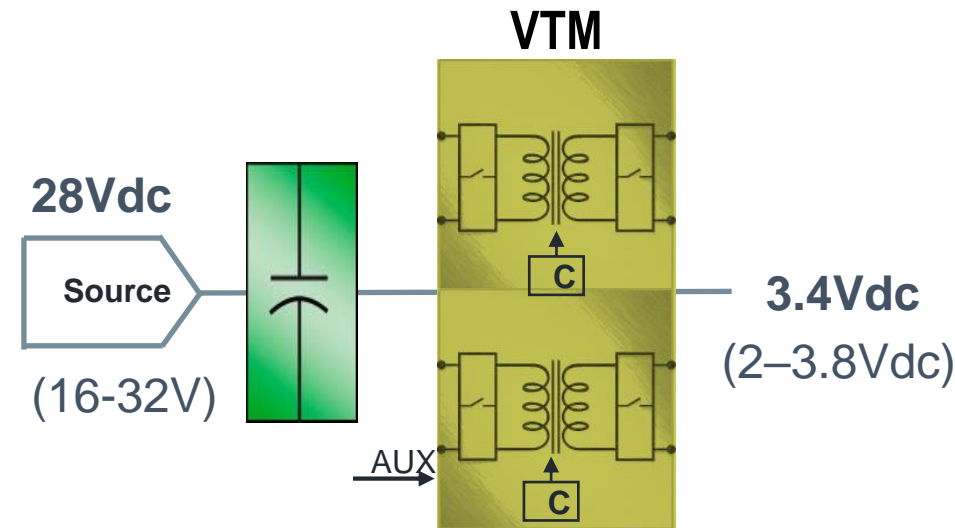
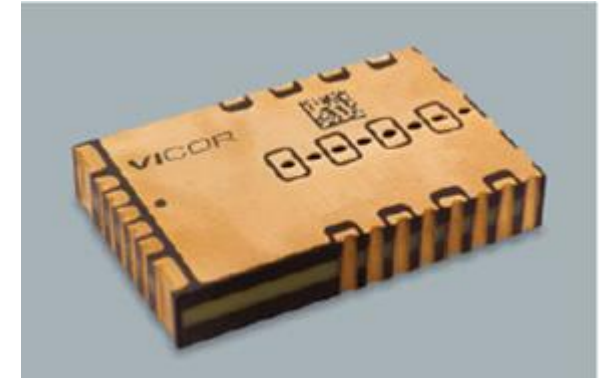
- $V_{in} = 14.4\text{-}35\text{Vdc}$
- $V_{out} = 0.42\text{-}1.0\text{V}$ ($K=1/32$)
- High efficiency (91%), reduces system power consumption
- High power density, Low Weight
 - $29 \times 19 \times 5.5\text{mm}$, 13g
- Contains built-in protection features against:
 - Overvoltage
 - Overtemperature
- ZVS / ZCS resonant Sine Amplitude Converter topology



50A Current Multiplier

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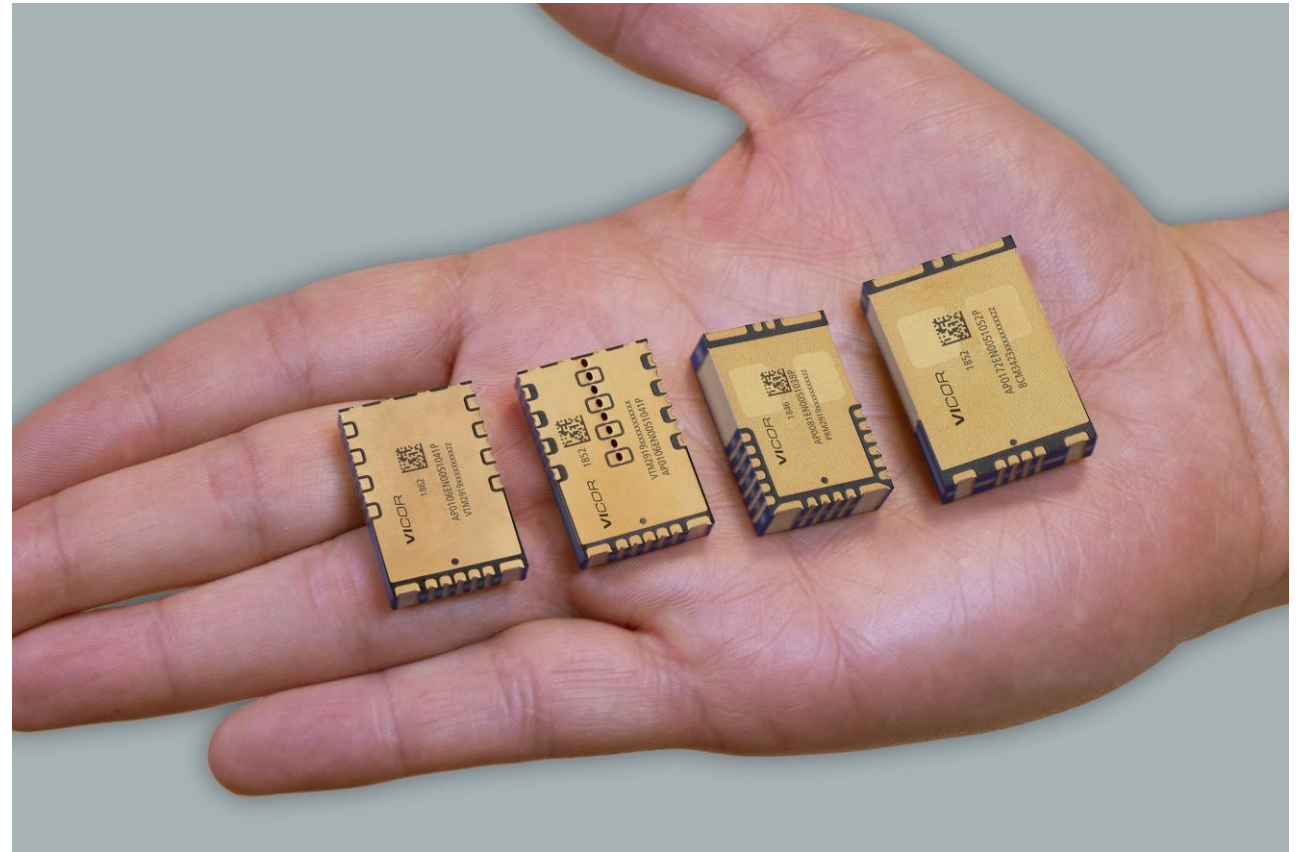
- $V_{in} = 16-32V_{dc}$
- $V_{out} = 2 - 3.8V$ ($K=1/8$)
- High efficiency (93%), reduces system power consumption
- High power density, Low Weight
 - 29x19x5.5mm, 10g
- Contains built-in protection features against:
 - Overvoltage
 - Overtemperature
- ZVS / ZCS resonant Sine Amplitude Converter topology



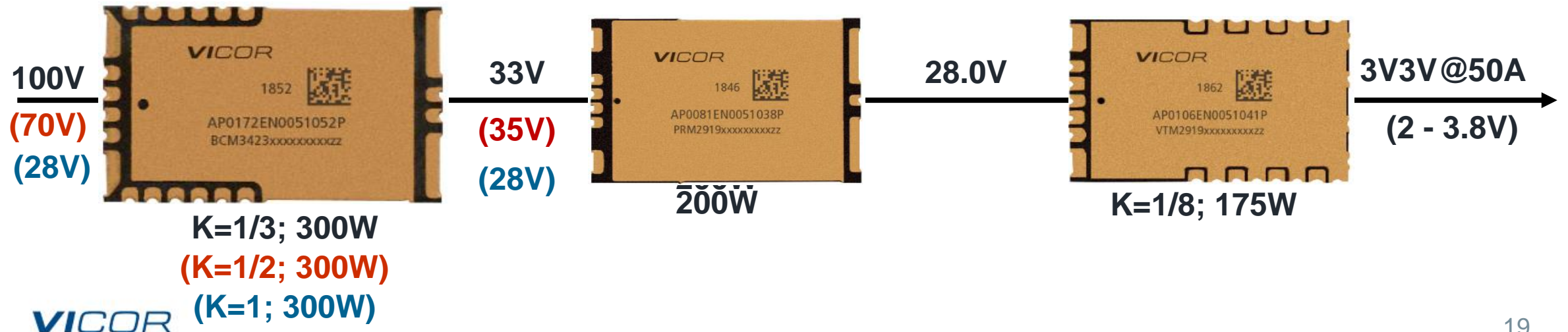
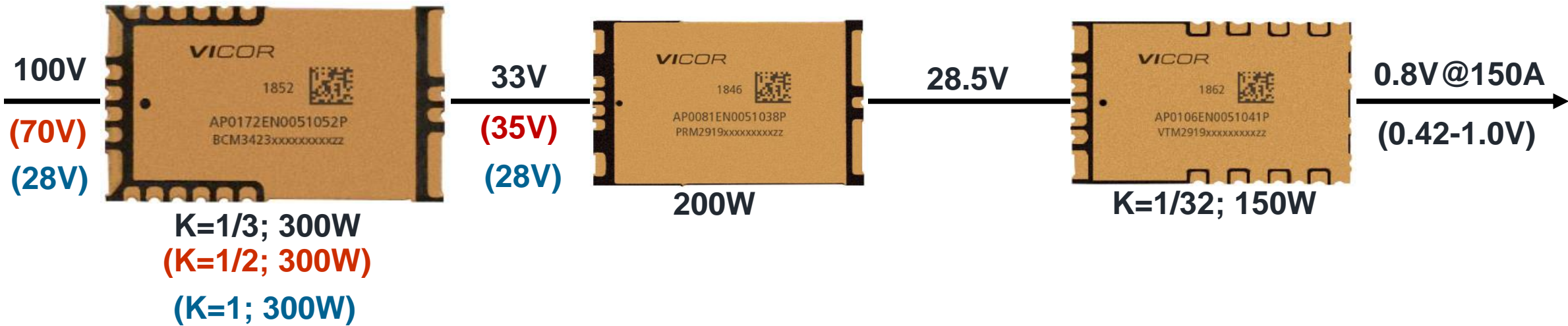
Modular Power Solution Capability

High Power Density Rad Tolerant Modules

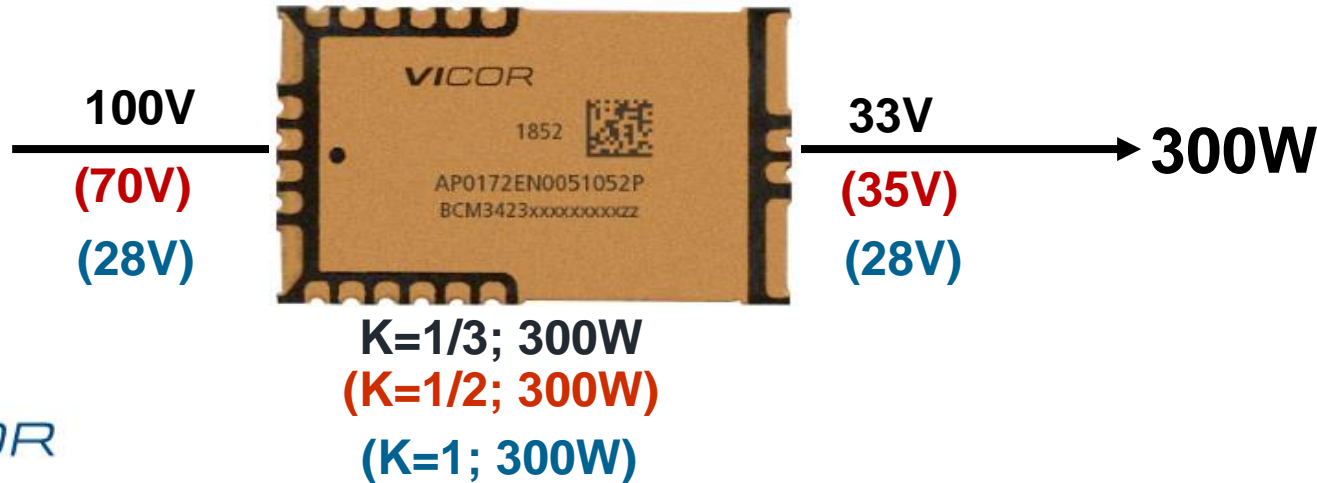
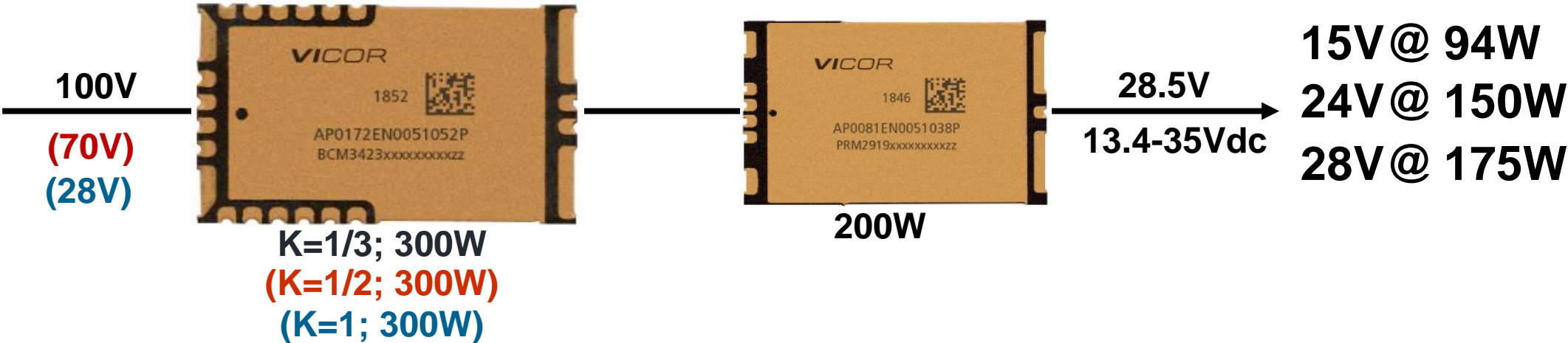
Vicor is looking for a partner for development of future devices



28V, 70V & 100V Buses Architecture



28V, 70V & 100V Buses Architecture



Thank you!

For questions & further information

- Contact Vicor at **XXXX**