

# MPS ESS Solution in Data Center

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2025/03

## □ Part 1: Datacenter Power Architecture Overview

- Standard Datacenter Power Architecture
- Traditional Server Rack & ORv3 Server Rack

## □ Part 2: Power Rack and BBU operation

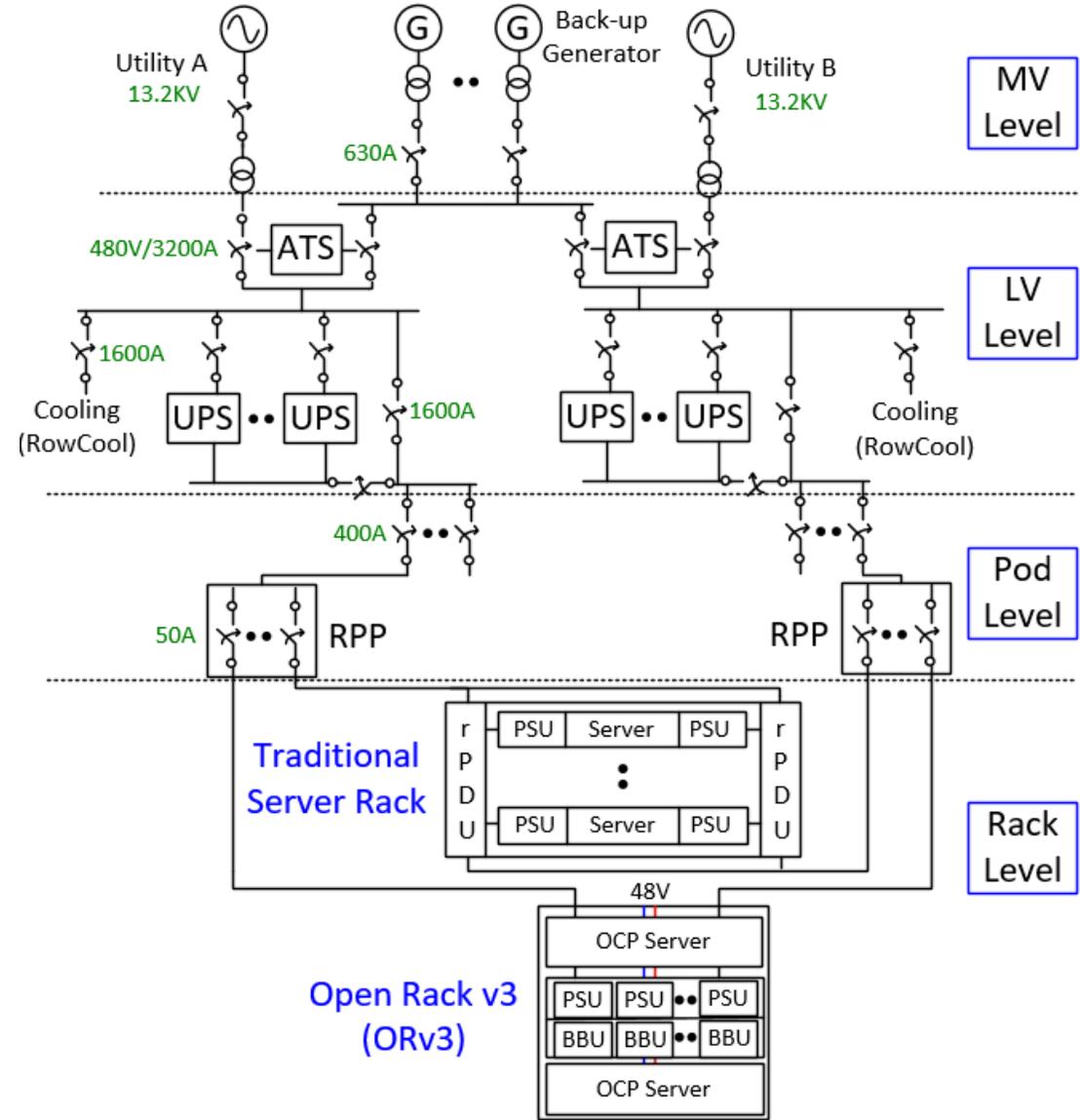
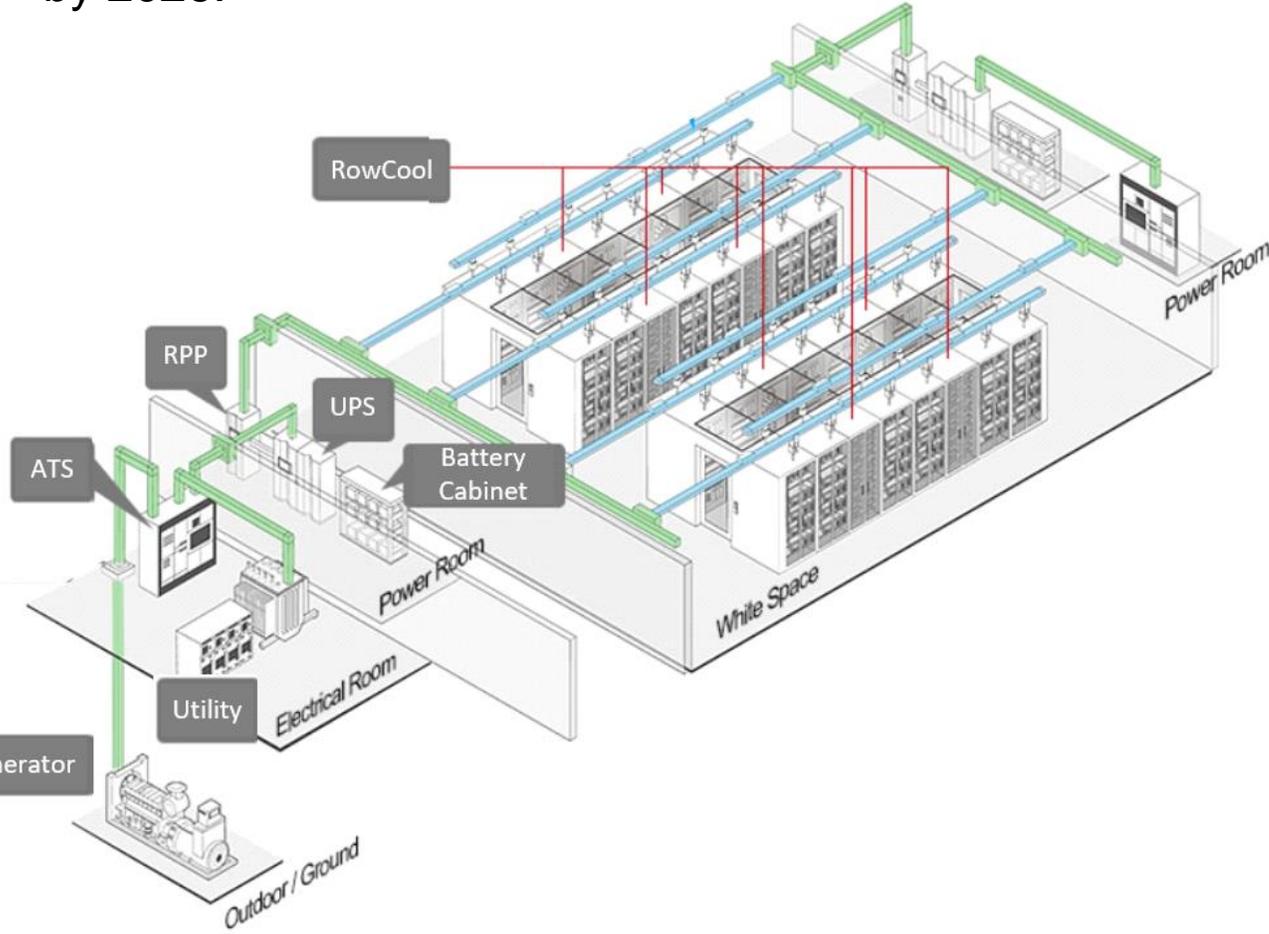
- PSU/BBU Power Transition
- BBU Operation

## □ Part 3: MPS BBU total solution

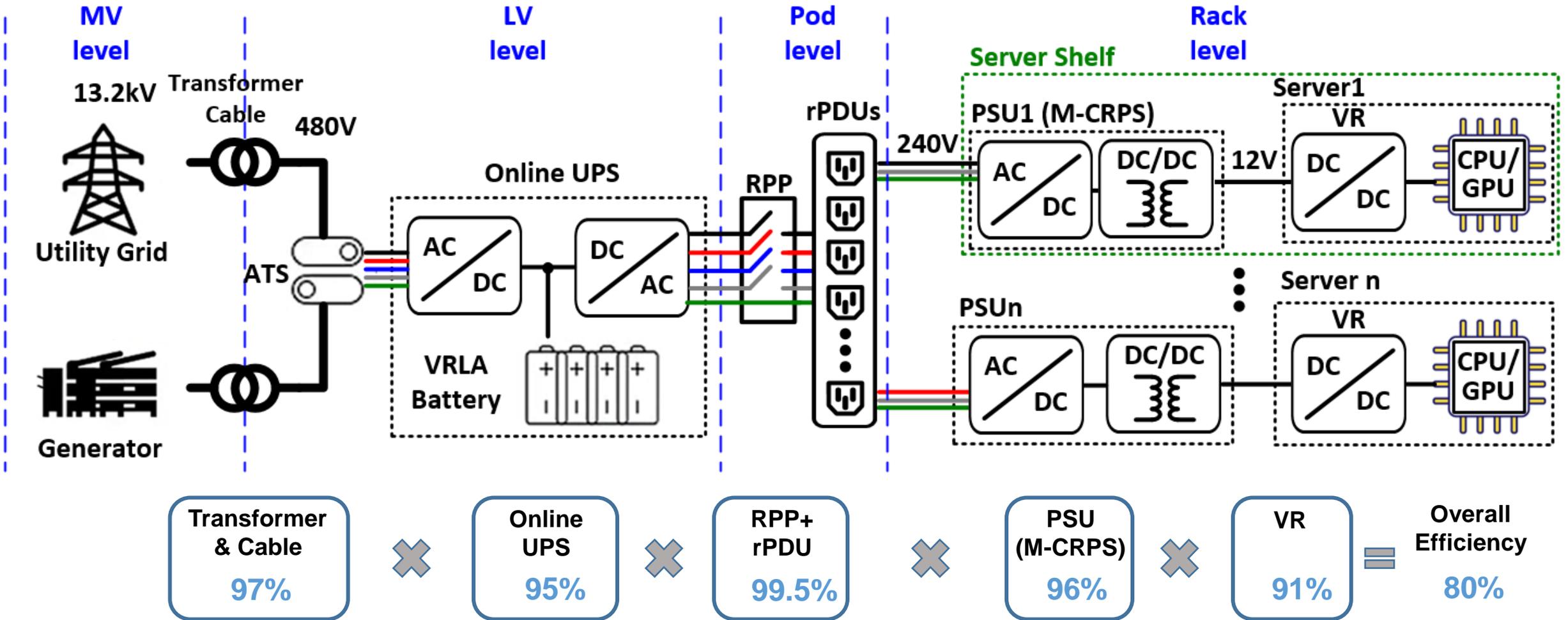
- BMS Board
- Charger/Discharger Board

# Standard N+N (2N) Datacenter Architecture

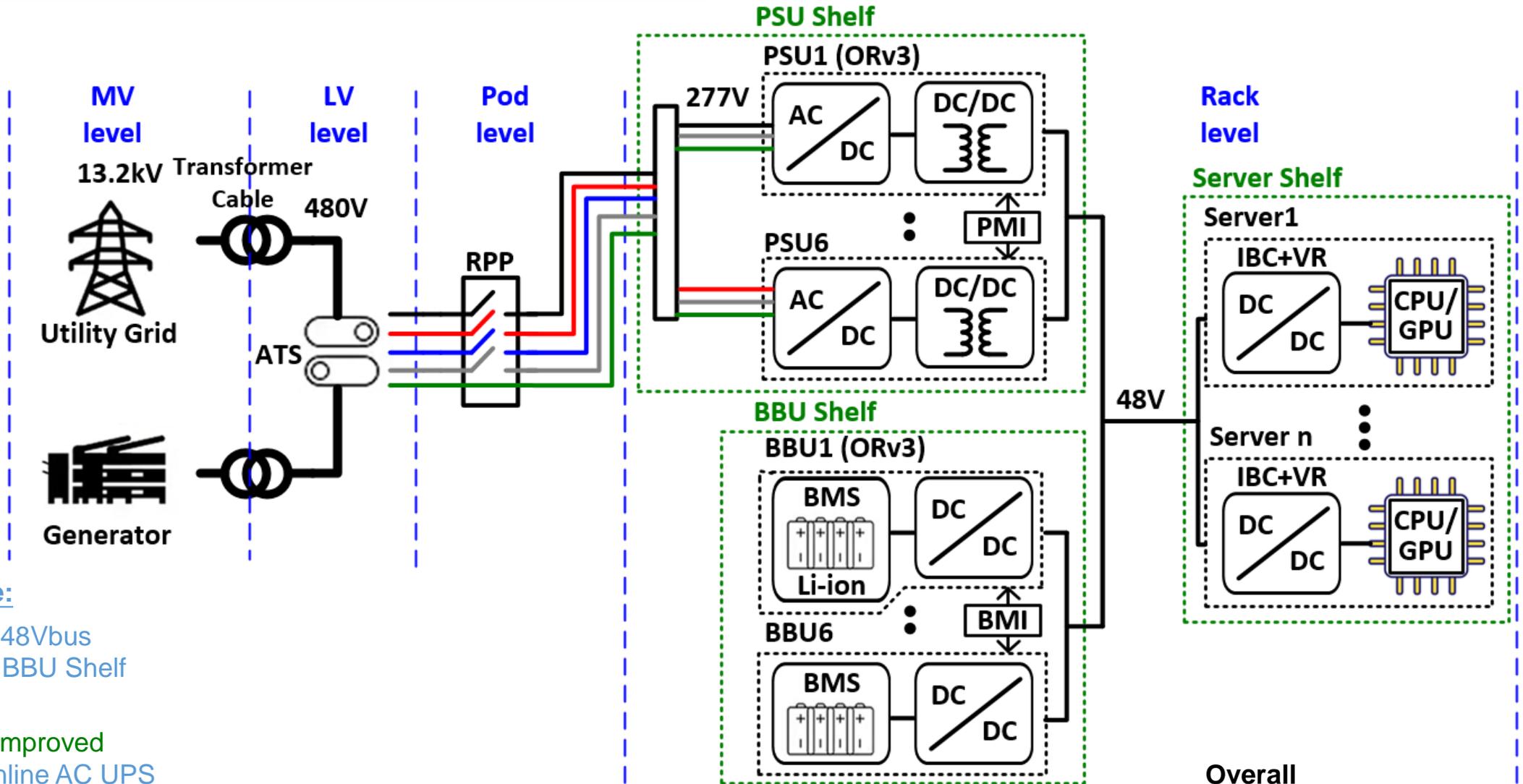
- Datacenter's total electricity consumption estimated to be 460 TWh in 2022, could reach more than 1,000 TWh by 2026.



# Traditional Server Rack Architecture



# ORv3 Server Rack Architecture



## Major Change:

- 12Vbus → 48Vbus
- AC UPS → BBU Shelf

## Benefits:

- Efficiency Improved
  - Remove online AC UPS
- Density Improved
  - VRLA battery → Li-ion battery

Transformer & Cable  
97%



PSU(ORv3)  
97.5%



IBC+VR  
90%



Overall Efficiency  
85%

# Traditional UPS Architecture vs ORv3 Architecture

	Traditional UPS Architecture	ORv3 Architecture	ORv3 Advantages
<b>Power Supply Mode</b>	Centralized UPS (Room Level)	Distributed Rack-Level Power Supply	Eliminates single points of failure, improves <b>reliability</b>
<b>Voltage Level</b>	AC (380V/220V)	48V DC	Reduces conversion losses, <b>efficiency</b> increased by 5-8%
<b>PSU Design</b>	Server-integrated AC-DC power modules	Rack-Level Centralized Rectification (RPP) + Distributed DC-DC Conversion	Simplify server design, lowers overall <b>costs</b>
<b>BBU Deployment</b>	Centralized Lead-Acid Battery Room (10-30ms switching delay)	Rack-Level Lithium Batteries, Directly Connected to PSU (<10ms switching)	Faster response, 60% less <b>space</b> occupancy
<b>Energy Efficiency (PUE)</b>	Typical PUE 1.5-1.8	Optimized PUE 1.1-1.2	Significantly reduces energy consumption
<b>Scalability</b>	Requires UPS capacity upgrades (high cost)	Plug-and-Play PSU/BBU modules per rack	<b>Flexible</b> adaptation to business growth
<b>Fault Impact Scope</b>	UPS failure may cause room-level downtime	Single rack failure does not affect others	Finer disaster recovery granularity

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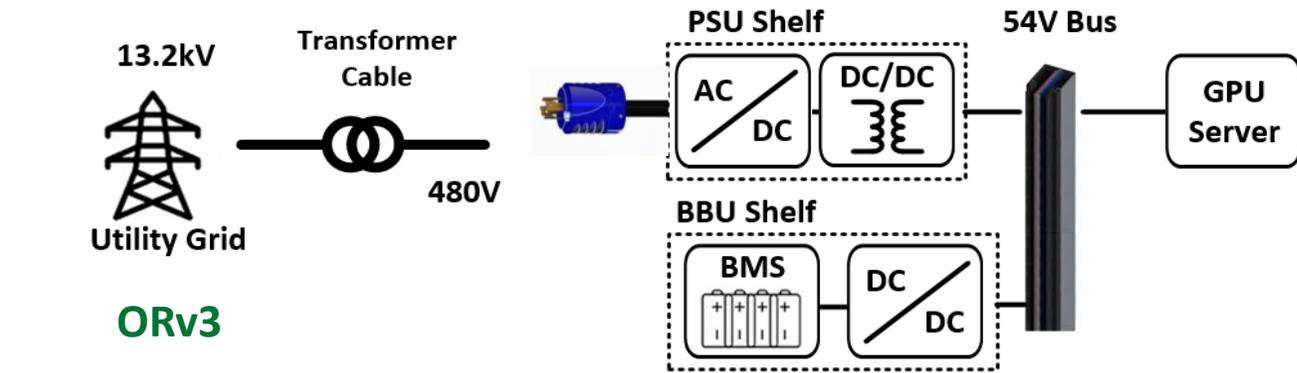
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- BMS Board
- Charger/Discharger Board

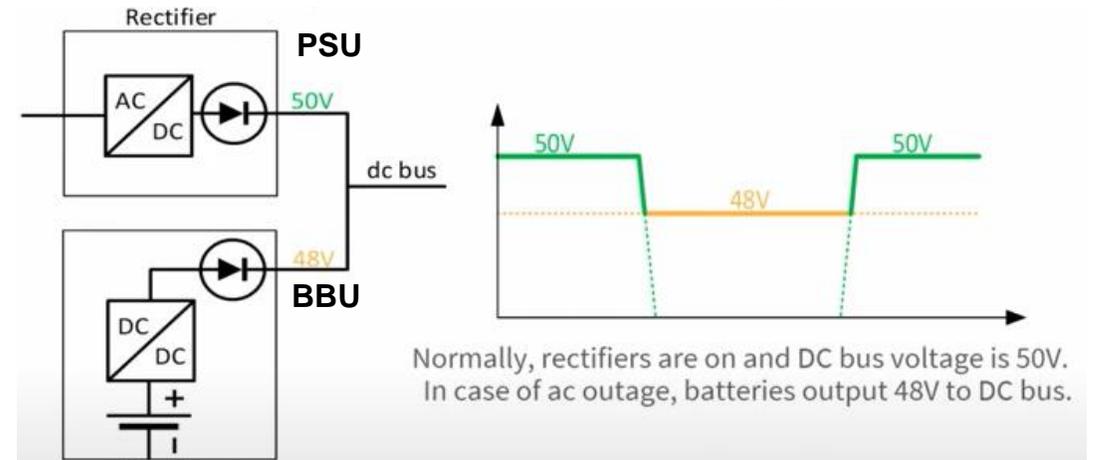
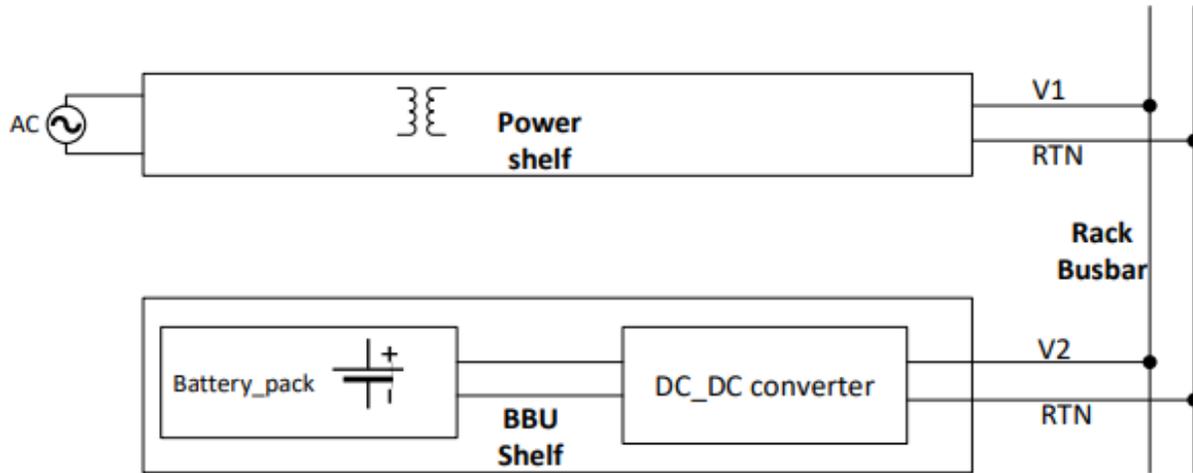
# Power Rack Operation



PSU shelf



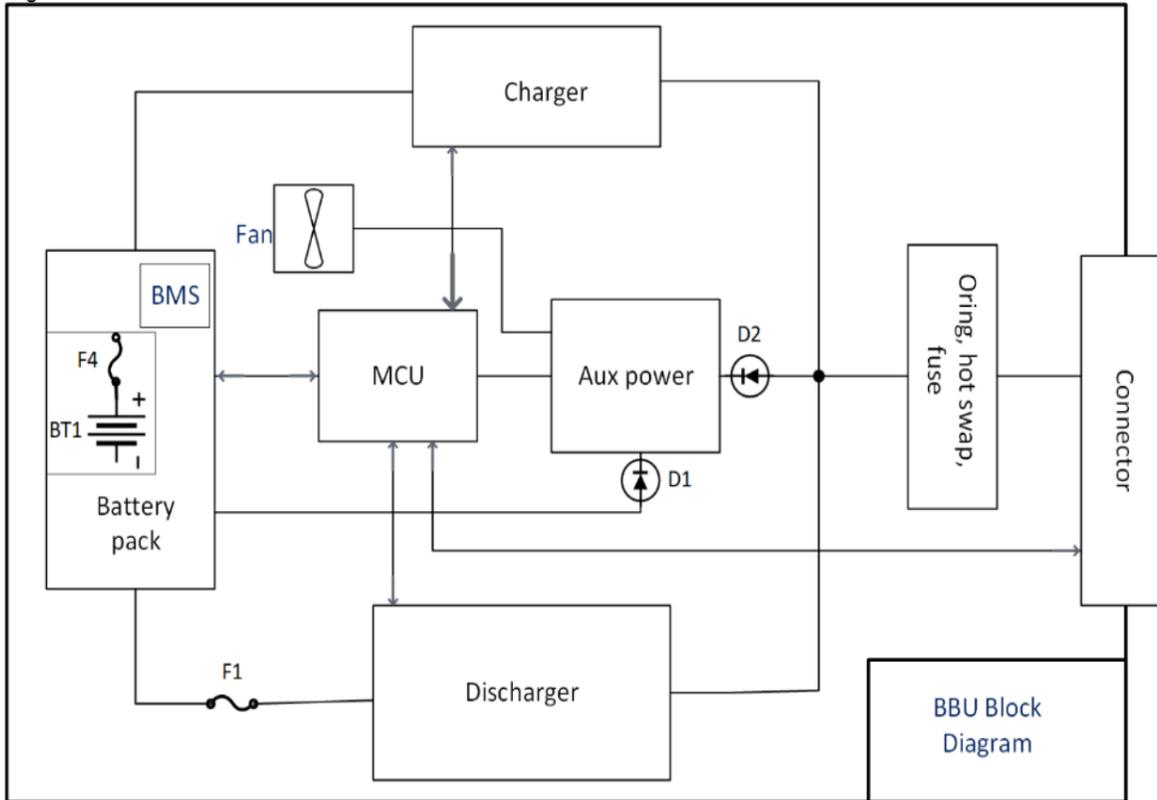
BBU shelf



- Under normal operation, PSU in power shelf provide rack busbar voltage. When power shelf loses AC input, the BBU shelf shall provide DC power to the rack. The BBU shelf backup time allows the rack to be switched between power sources with no disruption to the IT gears and allows drain/migrate applications before power loss.



# BBU Operation



## BBU Operation Mode

Sleep mode

Standby mode

Discharge mode

Charge mode

State of health check mode (SOH)

Periodical charge mode (PCM)

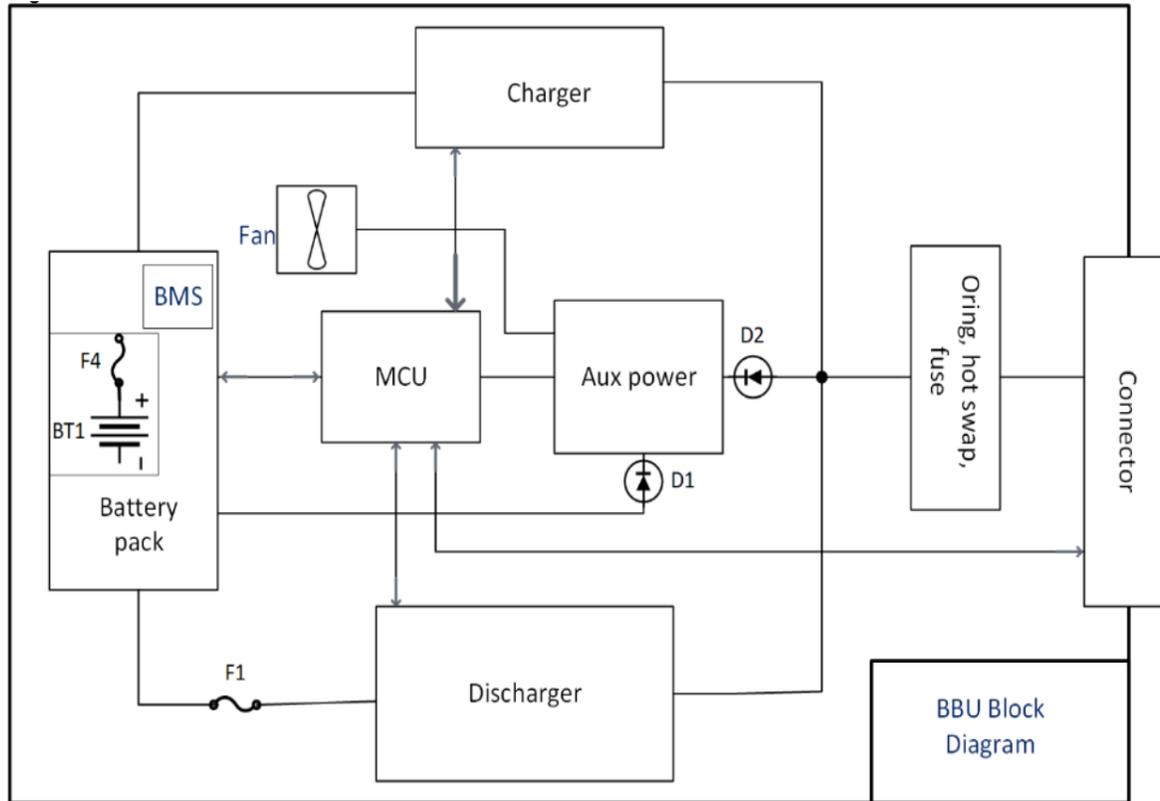
Fault mode

System control mode

Health check mode

- **Sleep mode:** BBU during transportation or stock → Minimize cell discharge current for longer storage time
- **Standby mode:** BBU monitors busbar voltage to be prepared for a discharge event. → Mostly for BBU
- **Discharge mode:** When busbar voltage drops and BBU takes over → High discharge rate in short time (ave. 10C)
- **Charge mode:** CC/CV charge based on previous depth of discharge. (Typically, <math><0.5C</math>)
- **SOH:** BBU routinely tests battery capacity through forced discharge of battery pack.
- **PCM:** Periodically charge BBU battery pack due to standby mode current leakage.

# BBU Operation



## BBU Operation Mode

**Sleep mode**

**Standby mode**

**Discharge mode**

**Charge mode**

**State of health check mode (SOH)**

**Periodical charge mode (PCM)**

**Fault mode**

**System control mode**

**Health check mode**

- **Fault mode:** BBU not allow to charge/discharge due to software/hardware fault.
- **System control mode:** Upstream system controls BBU through communication bus.
- **Health check mode:** System level health check.

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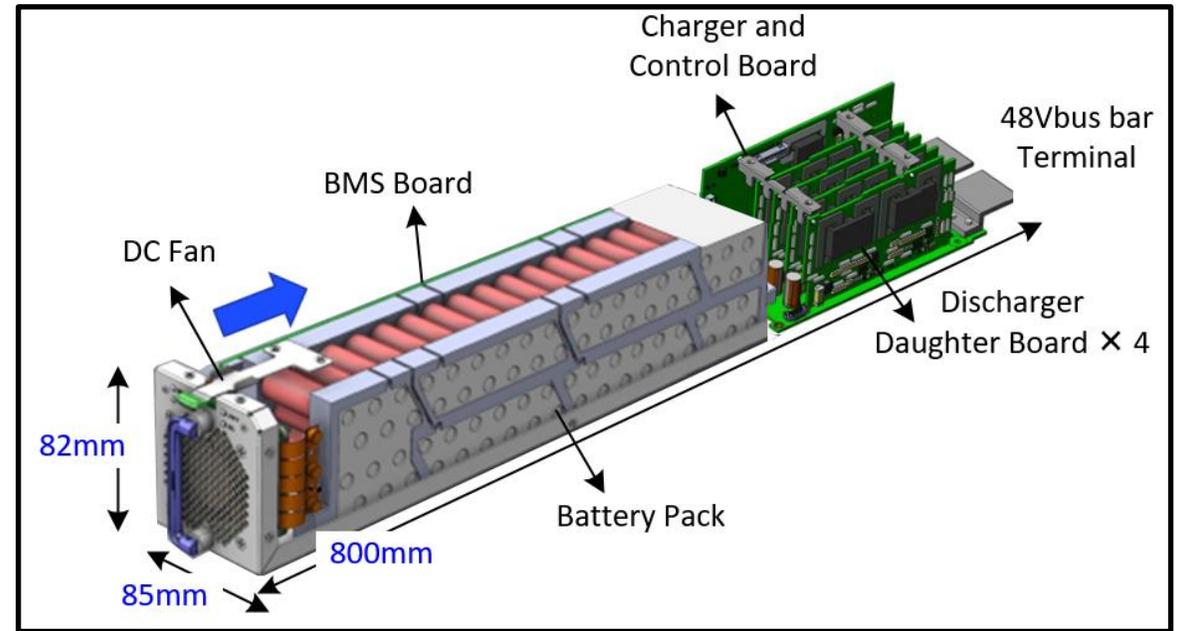
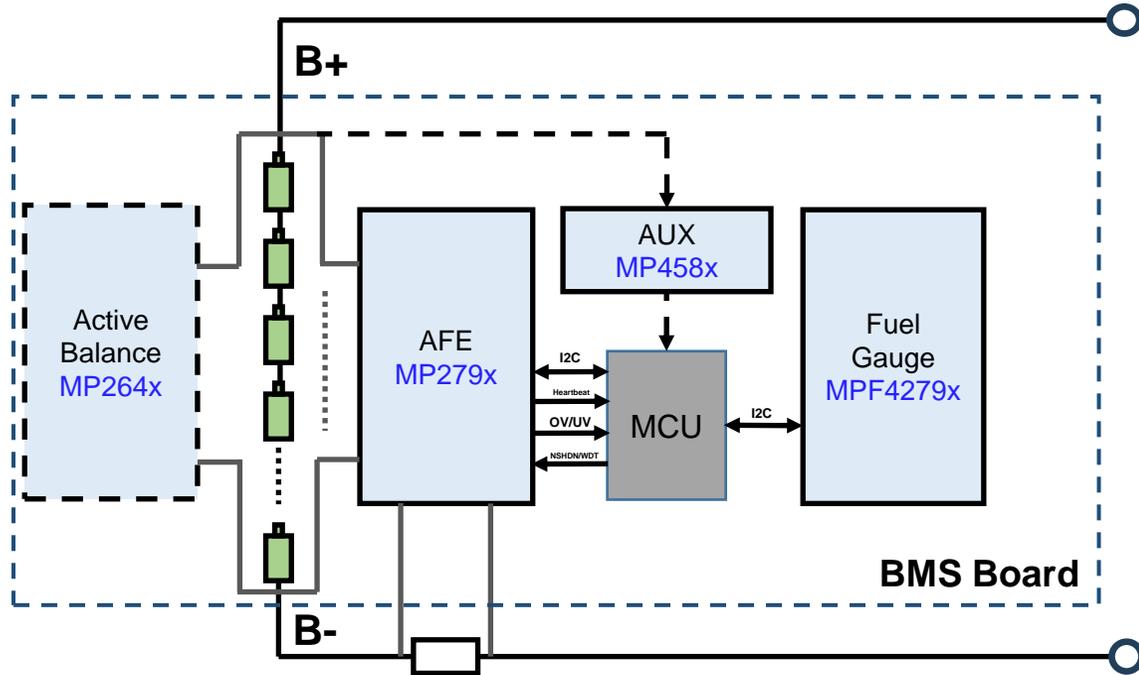
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## □ Part 3: MPS BBU total solution

- BMS Board
- Charger/Discharger Board

# BBU BMS Implementation



## BMS Board

- The BMS shall include a protection mechanism and logic circuitry to generate and control algorithms and signals used in the BBU. The BMS shall also include a cell balancing circuit where the cell voltage on all battery cells in a pack are kept within +/-1%. The BMS shall provide system monitoring and control functions through the communication bus. The BMS shall support other functions such as SOH, SOC, PCM, failure events log, remote FW upgrade, etc.

- ❑ **AFE:** Provide cell voltage, current, temperature and fault signal.
- ❑ **Fuel Gauge:** Provide SOC/SOH, etc.
- ❑ **Active balance:** Provide larger balance current during charge and ease cell unbalance during discharge.
- ❑ **Auxiliary power supply:** Provide aux power with low Iq.

# BMS Product Roadmap

## Battery Monitor & Protector



## Fuel Gauge



## Active Balancer



<p><b>MP2790/3</b> 4s to 10s/16s HS FET Drivers, Coulomb Counter, Soft-start</p>	<p><b>MP2797(A)</b> 7s to 16s HS FET Drivers, Coulomb Counter, Soft-start</p>	<p><b>MP37xx</b> 3s to 7s Independent HS FET Drivers, Coulomb Counter, Fuse Control, Adv Soft-start</p>	<p><b>MP37xx(A)</b> 3s to 18s, Independent HS FET Drivers, Coulomb Counter, Fuse Control, Adv Soft-start</p>
<p><b>MP2787</b> 7s to 16s No FET Drivers, Coulomb Counter</p>	<p><b>MP27xx</b> 3s to 18s No FET Drivers, Coulomb Counter, Fuse Control</p>	<p><b>MP37xx</b> 3s to 10s, Independent HS FET Drivers Coulomb Counter, Fuse Control, Adv Soft-start</p>	
<p><b>MPF42791</b> 2-16s Li-Ion / Li-Po w/ Cell Impedance &amp; Thermal Modeling</p>	<p><b>MPF42793</b> 2-16s w/ Cell Impedance Monitoring, Thermal Modeling, LiFePO4</p>	<p><b>MPF427xx</b> Direct I/F to MP37xx 2 to 10s/18s LiFePO4, LiPo, Li-Ion Complete Feature Set</p>	<p><b>MPF427xx</b> Supports HV String Up to 112s LiFePO4, LiPo, Li-Ion Complete Feature Set</p>
<p><b>MP2640</b> 2s Bi-directional Buck- Boost Interleavable, 2.5Amp</p>	<p><b>MP2641</b> 2s Bi-directional Buck- Boost, Interleavable, 2.5Amp, 2.1V Min Vcell</p>	<p><b>MP2642</b> Optimized Control 2s Bi-directional Buck- Boost, 1Amp</p>	<p><b>MP2643</b> Optimized Control 2s Bi-directional Buck- Boost, 2Amp</p>

Released

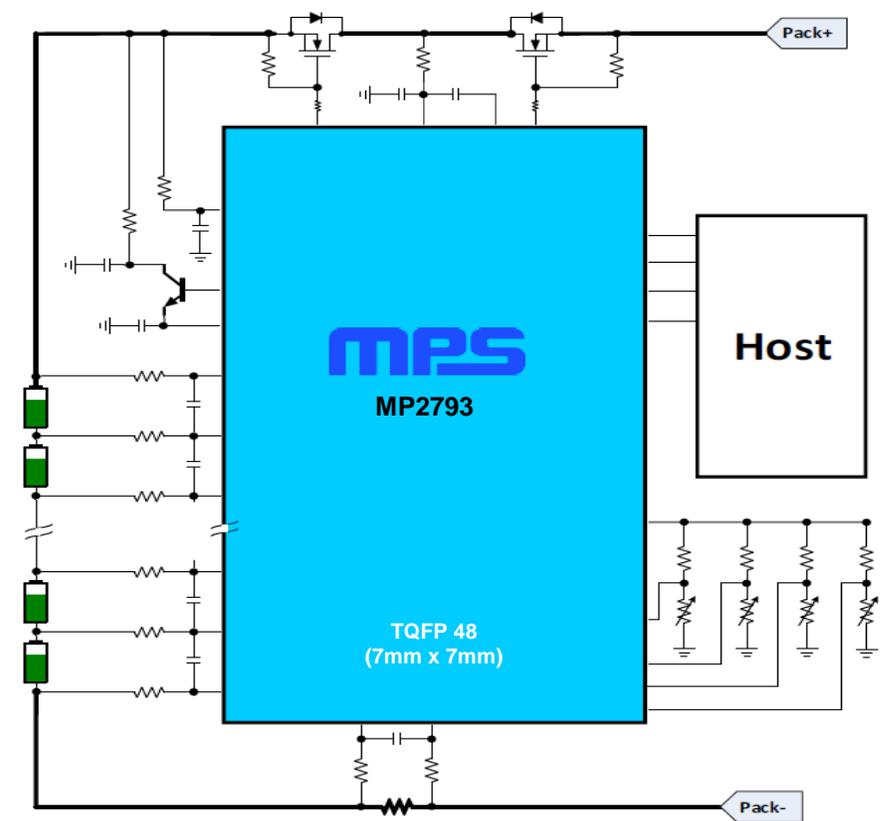
Sampling

Timeline

# MP2793 16-Channel Battery Monitor & Protector

## Basic Overview

- Voltage Measurements for 4 Series Cells, up to 10/16 Cells
  - Accuracy:  $\pm 5\text{mV}$  ( $25^\circ\text{C}$ ) /  $\pm 12.5\text{mV}$  ( $-40^\circ$  to  $85^\circ\text{C}$ )\*
  - Supports Battery Chemistries from 2V to 4.5V
  - Operates from 10V to 75.2V
- Current Measurements
  - Synchronized Current Snapshot w/ Each Cell Voltage
  - Accuracy:  $\pm 0.5\%$  ( $23^\circ\text{C}$ ),  $\pm 1\%$  ( $-40^\circ$  to  $85^\circ\text{C}$ )
  - Includes Coulomb Counting Function
- Integrated, Independently Controlled High Side N-FET drivers
  - Soft-start Turn-on Feature (Protects FET during Start-up, Eliminates Pre-charge)
  - Strong Pull-down Driver (Protect FET from Short Circuit Condition)
- Internal Passive Balancing up to 58mA per Cell
  - Designed to Drive External FET or NPN for Higher Current
- Regulated 3.3V Output for MCU (up to 50mA)
- Shutdown Current  $< 2.5\mu\text{A}$
- Temperature Monitors (4 NTC Inputs + IC Die)
- High Voltage & Low Voltage GPIOs
- I2C or SPI communication with CRC
- MTP Memory to program project dependent critical parameters



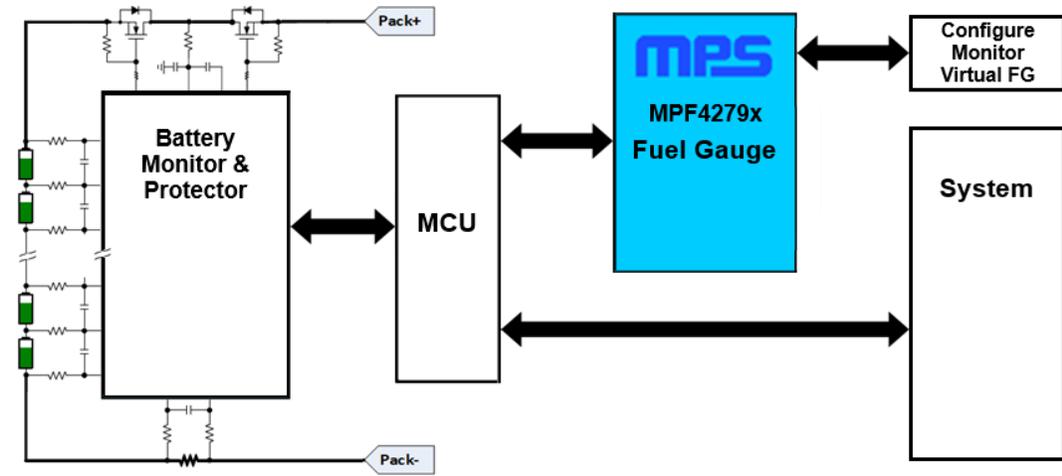
## Safety Features

- Cell-level Fault Detection: Over-voltage, Under-voltage, Dead Cell, Unbalanced-cell, Open-wire
- Pack-level Fault Detection: Over-voltage, Under-voltage, Over-current, Short-circuit
- DSG / CHG FET Controlled Separately Under Fault Conditions
- Communication Watchdog Timer
- ADC Self-test
- Random Cell Connection Tolerant

# MPF42791/3 Battery Pack Fuel Gauges

## Basic Overview

- Provides Fuel Gauge Estimates for 2 to 16 cells
  - MPF42791: Optimized for NMC/NCA ( $\pm 2\%$  Accuracy w/ MP2797)
  - MPF42793: Optimized for LFP ( $\pm 5\%$  Accuracy w/ MP2797)
- Provides Critical Battery Information:
  - Pack and Cell State-of-Charge (SoC)
  - Pack and Cell State-of-Health (SoH)
  - Remaining Run Time and Charge Time
  - Instantaneous Available Power
  - Real-time Cell Resistance
- Adaptive Learning Capability:
  - Refine Initial Charge Settings
  - Refine Initial Discharge Settings
  - Update Cell SoH to track degradation
  - Update Cell ESR to track degradation
- Lifetime Logging of Key Parameters
- 5-Level LED SoC Indicator w/ Push-button Trigger
- 2.5V Minimum Supply Voltage
- 6 $\mu$ A Shutdown Current
- Dual I2C Communication Interfaces (up to 400kHz)



## Standard Fuel Gauge Architecture

- Compatible w/ Commonly Used Battery Monitors
  - Easy to Add to Pre-existing Designs
  - MPS GUI Supports Fuel Gauge in any Design (via 2<sup>nd</sup> I2C Port)
- Battery Monitor & Fuel Gauge have Independent Interfaces
- Local MCU
  - Acts as a Liaison between Battery Monitor & Fuel Gauge
  - Provides System-level Interface

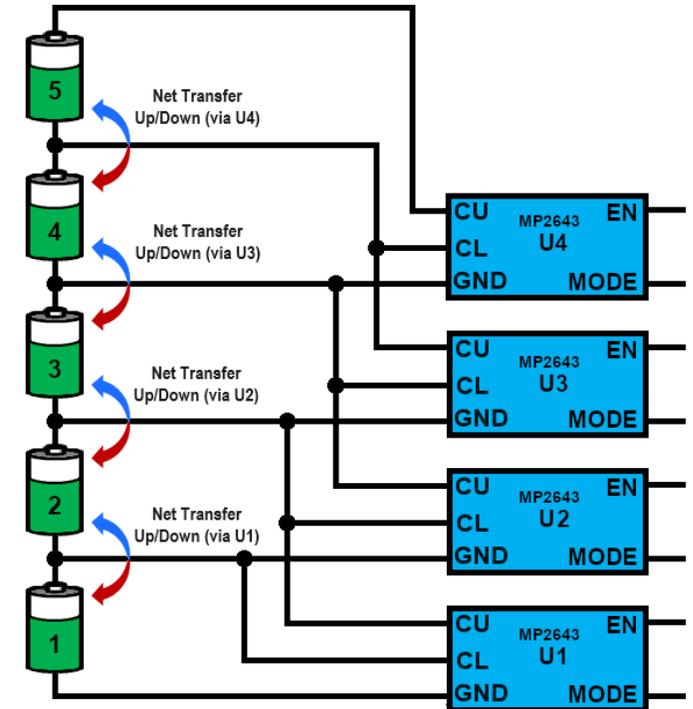
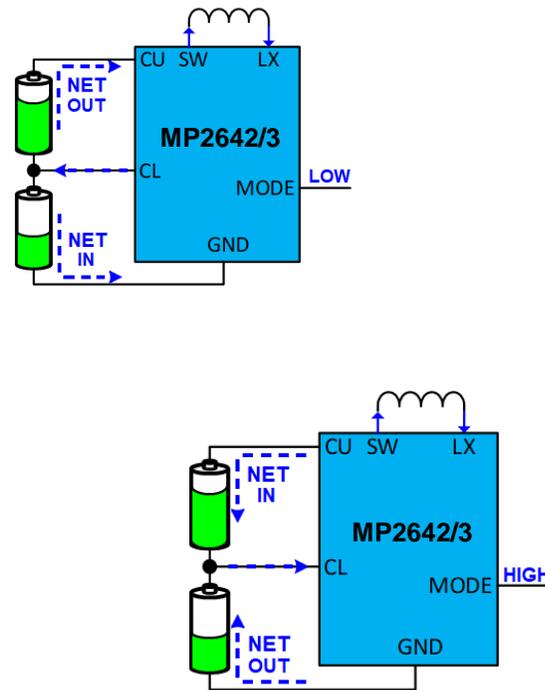
# MP2642/3 Active Balancers

## Product Overview

- Integrated High Current FETs
- Cell Voltage Range: 2.4V to 4.35V
- Programmable Cell-to-cell Balancing Current
  - MP2642: 1 Amp Max Net Transfer
  - MP2643: 2 Amp Max Net Transfer
- Integrated Protection Features
  - Thermal Shutdown
  - Battery Reverse Leakage Blocking
  - Low Voltage Protection in Boost-Balance Mode
- Directly Powered from the Battery Cells
- Interleavable for Transfer Across Many Cells
- >92.8% Charge Transfer Efficiency @3.3V
- QFN-26 (4mmx4mm) Package

## Simple & Low-cost

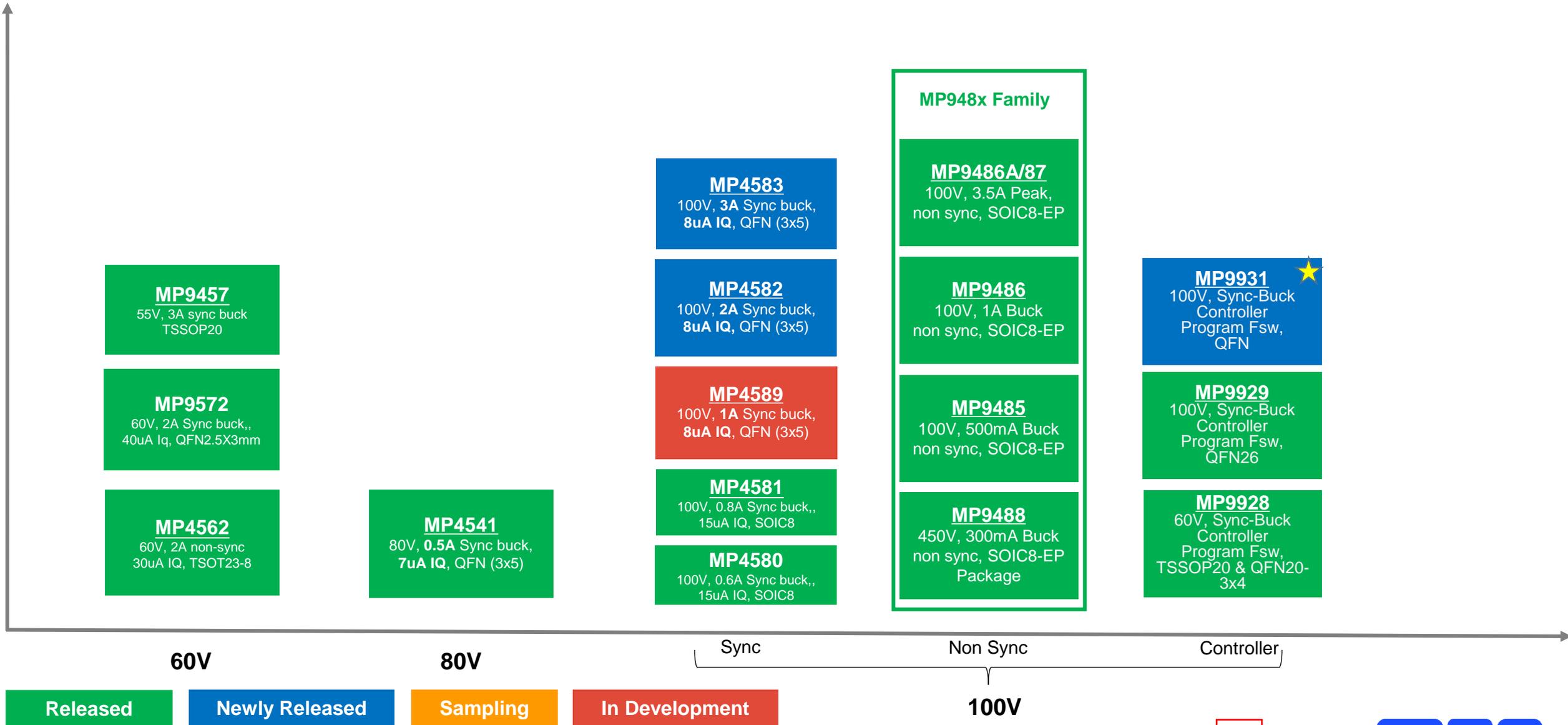
- Single Inductor, Capacitor
- Small 4mmx4mm QFN-26 Package
- Easy to Control



## Value Add

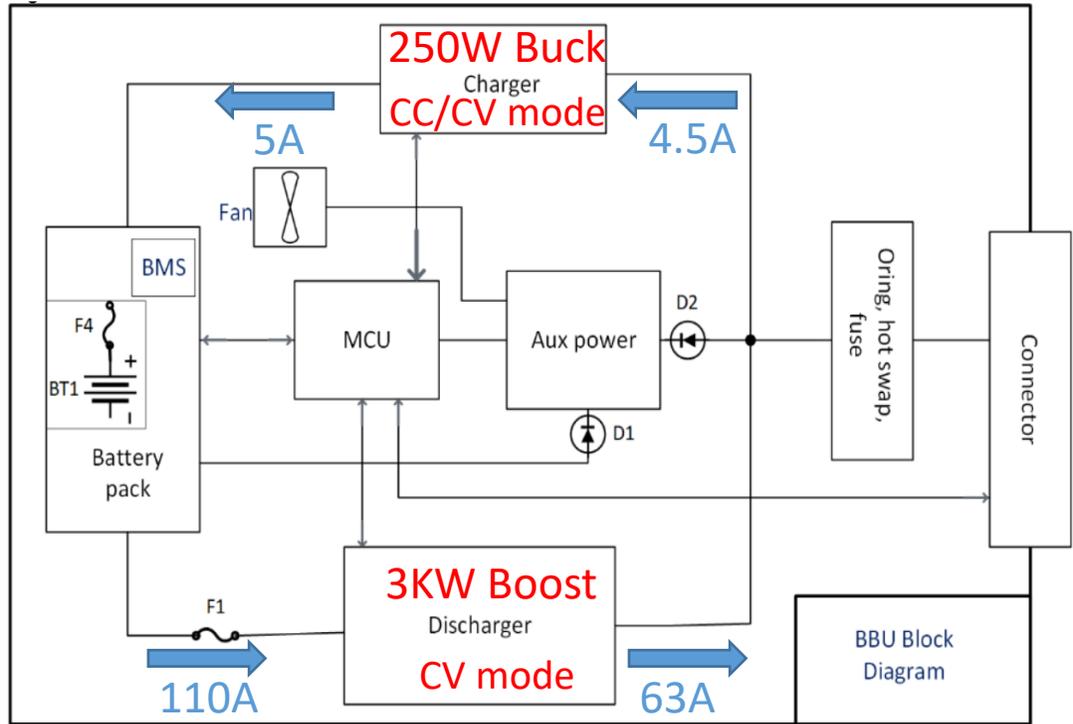
- *Faster Balancing (Enables Short Cycle Operation)*
- *Lower Cost Thermal Design (Reduced Thermal Load)*
- *Improved Energy Efficiency (Redistributes vs Dissipates)*
- *Increased System Runtime when used During Discharge*

# HV Buck Roadmap (60~100V)



# BBU Charger Implementation

28-44V pack



48V bus

OCP BBU	Charge Mode	Discharge Mode
Power Rating	250W	3000W
Min. Efficiency @50% load	95%	97%
Topology	Buck	Boost
Regulation Mode	CC/CV mode	CV mode
Min. Hold-up time	-	240s
Max. Charging time	6Hours	-

## 4.8 Redundancy and Hot Swap

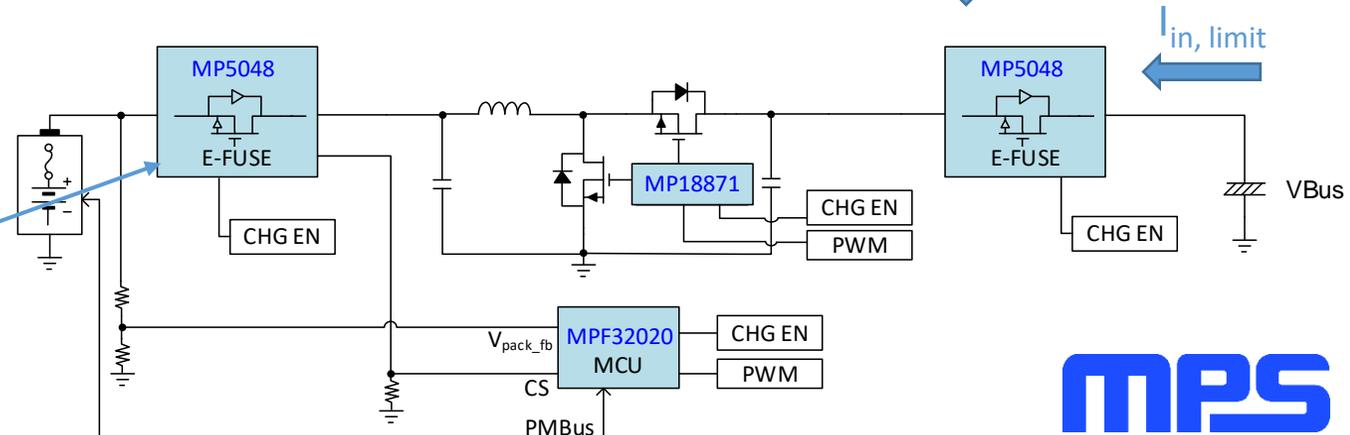
Hot-swap are needed on any circuits connecting to busbar voltage to avoid busbar voltage disturbance at hot swap and component single fault.

## 4.9 Fuses should be placed at the following locations:

- (1) between battery pack and discharger input
- (2) [on charger input](#),
- (3) on Aux converter input.
- (4) There should be [a controlled fuse](#) between the charger and battery pack to protect against charger faults such as OVP.

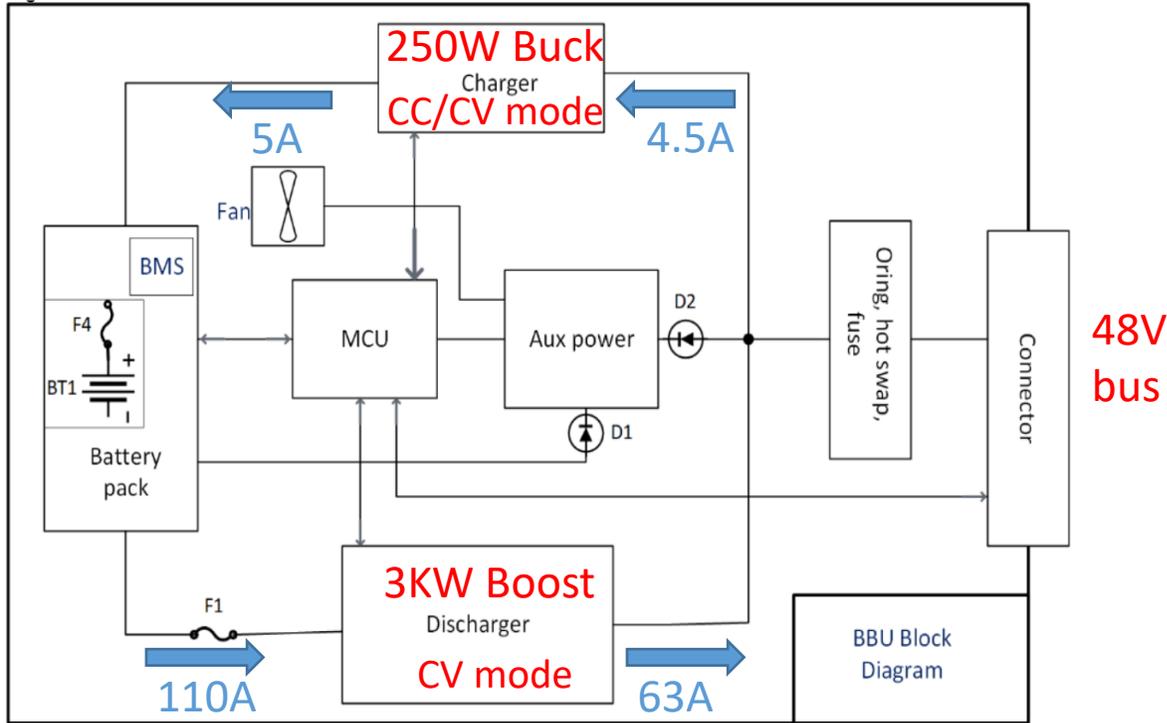
MP5048 can be used as:

1. Controlled fuse
2. Current sensing for CC mode charging control ( $I_{charge} = 0-5A$  programmable)
3. Inrush current suppressor



# BBU Discharger Implementation

28-44V pack



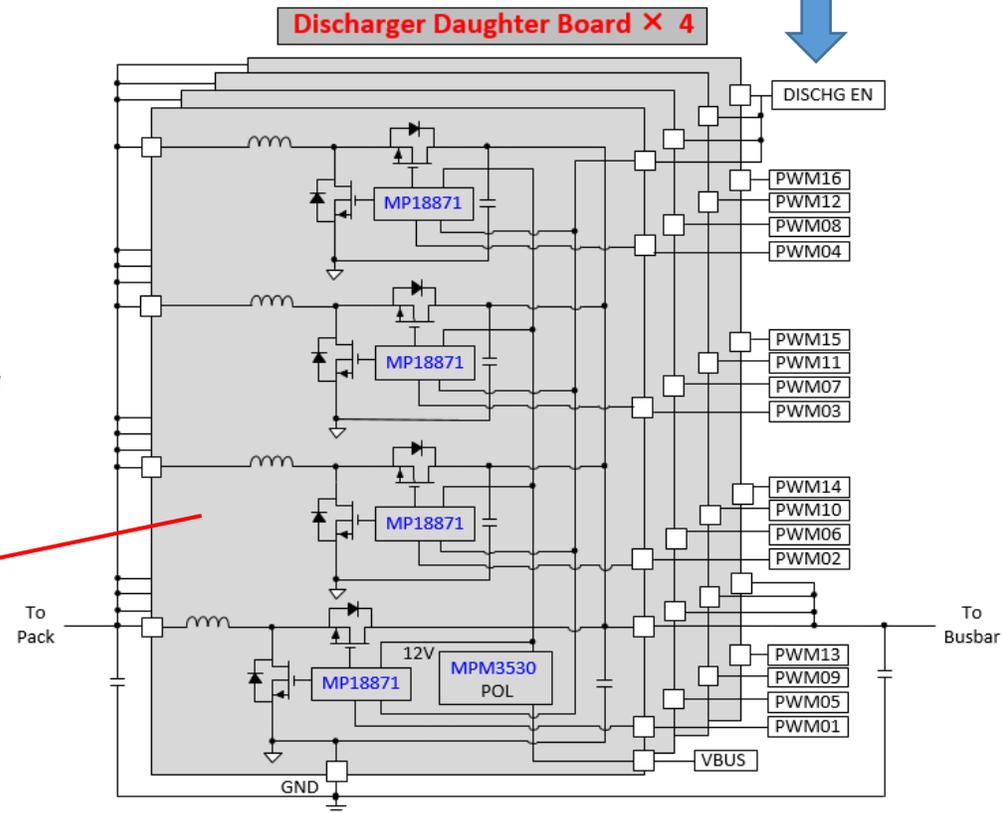
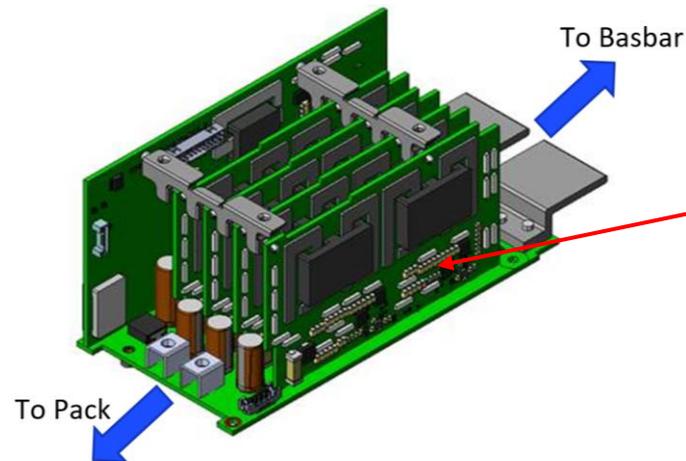
OCP BBU	Charge Mode	Discharge Mode
Power Rating	250W	3000W
Min. Efficiency @50% load	95%	97%
Topology	Buck	Boost
Regulation Mode	CC/CV mode	CV mode
Min. Hold-up time	-	240s
Max. Charging time	6Hrs	-

## Modular Daughter Card Design:

- Increasing space utilization
- Easy to extend power rating
- Simplify PCB layout

## Interleaved Topology:

- Reduce input and output ripple
- Reduce filter size
- Improve dynamic response



# MP27xx Bi-directional Buck-Boost Controller

## Features

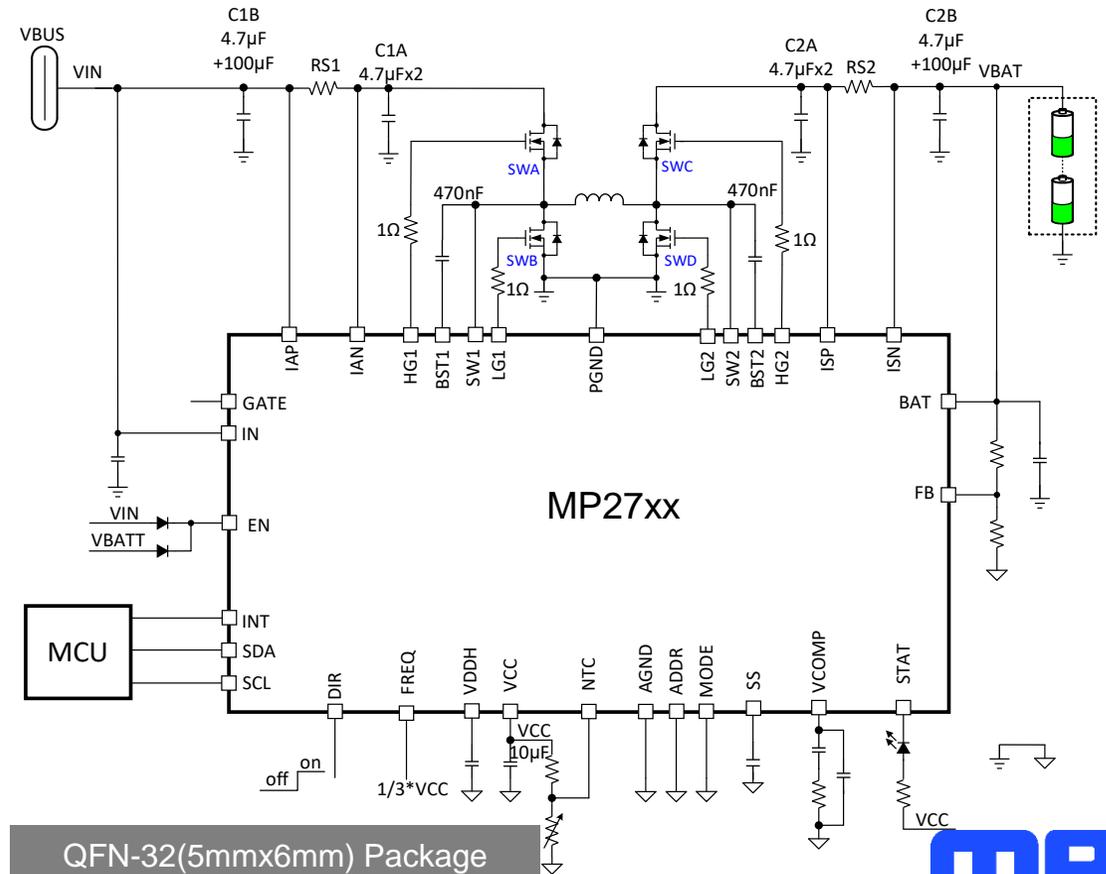
- 4-switch Bi-directional Buck-boost Controller
- 4.75V-100V Operation Input Voltage Range
- Up to 11-cell Li-ion or 13-cell LiFePO4 charge profile
- 1 $\mu$ A EN Shutdown IQ
- Programmable Input / Output Current limit,
- 0.5A-25A with 50mA/step`
- Support USB PD SPR PPS and EPR AVS
- 150kHz/300kHz/450kHz/750kHz Switching Frequency
- I<sup>2</sup>C Interface with interrupt function
- OCP, OVP, PG, NTC and thermal shutdown
- 10-bit ADC for VIN, IIN, VOUT, IOUT and Temperature
- QFN-32 (5mmx6mm) package.

## Applications

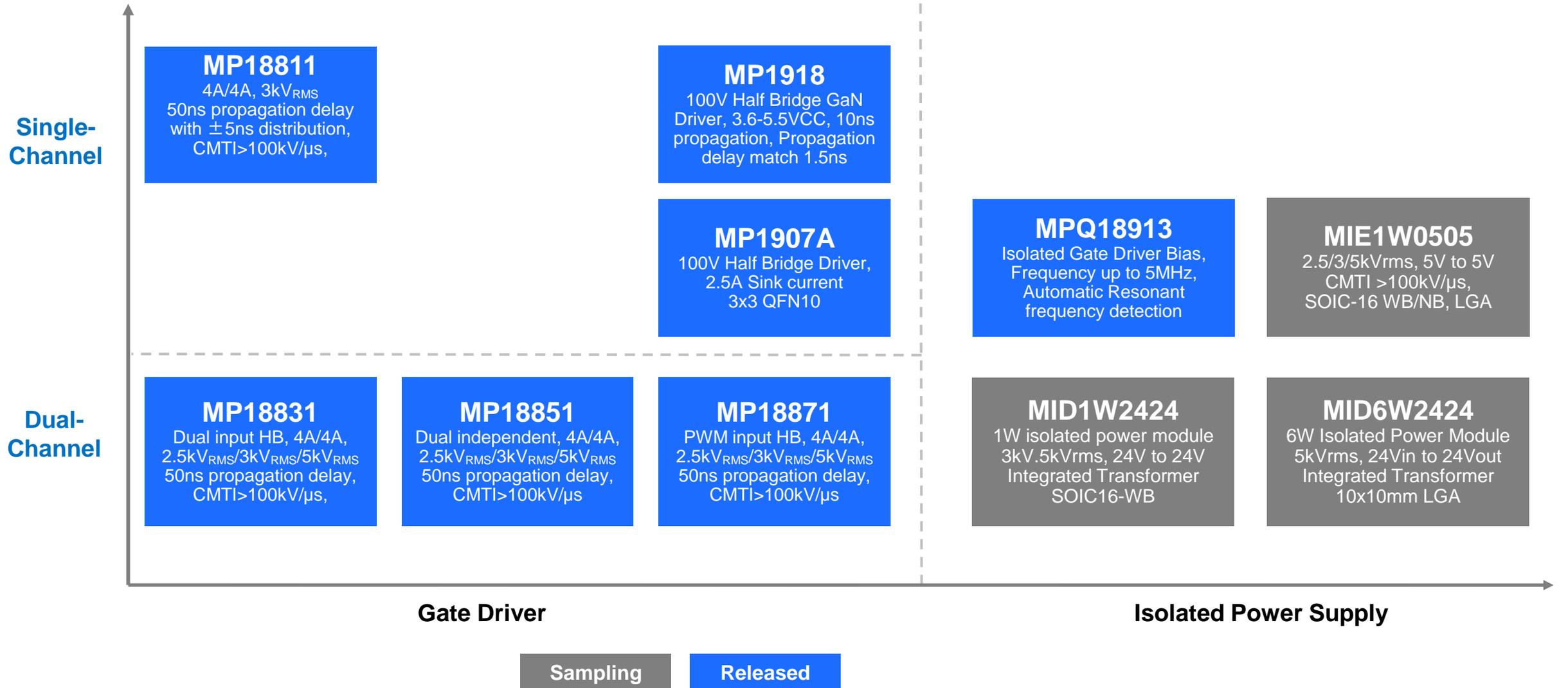
- E-bike, ESS, Solar Camera, Power tools, Vacuum, Speaker, Sweeper

## Key Benefits

- USB EPR Power Delivery
- High power applications
- 100V bi-directional converter for up to 25A current



# Isolated Gate Driver/Power Supply Road Map

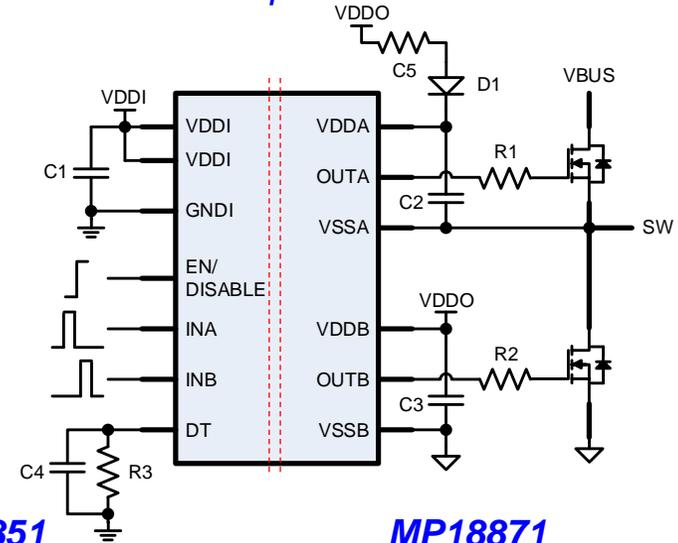


# MP1883/5/71 - Isolated Dual-Channel Gate Driver

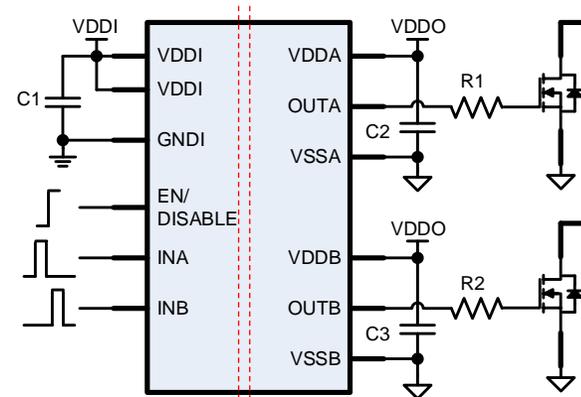
## FEATURES

- Flexible Configuration: Rich Family, Independent Dual-Channel Driver, Dual-/PWM-Input Half-Bridge Driver
- Up to  $5kV_{RMS}$  Isolation
- $CMTI > 100kV/\mu s$
- TTL and CMOS Compatible Inputs
- 30V Output Drive Supply with UVLO Options (5V/8V/10V/12V/15V)
- 4A Source/ 8A Sink Peak Current Output
- 50ns Typical Propagation Delay (20ns typ. for MPQ188xx)
  - Tight  $\pm 5ns$  Distribution from Part to Part
- Operating Junction Temperature Range  $-40^{\circ}C$  to  $+150^{\circ}C$
- Standard Packages: Narrow Body SOIC-16; Wide Body SOIC-16, 5mm x 5mm LGA-13
- Applications: Solar Inverters, DC/AC Inverters, Offline isolated AC/DC Converters, Half/Full Bridge Converter, Bias for IGBT/SiC/MOSFET

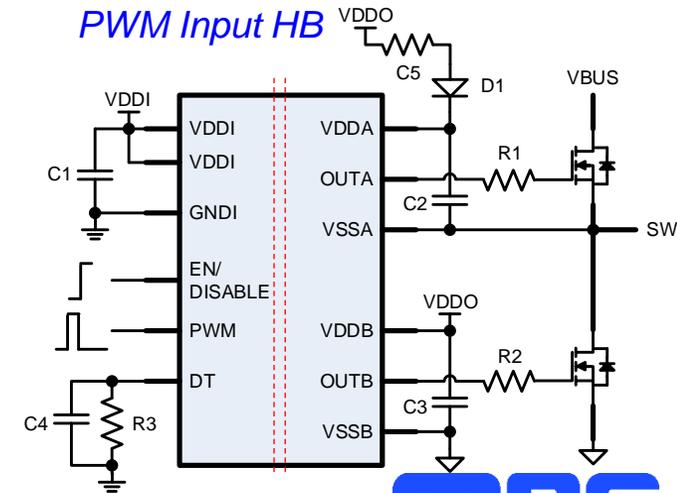
**MP18831**  
*Dual Input HB*



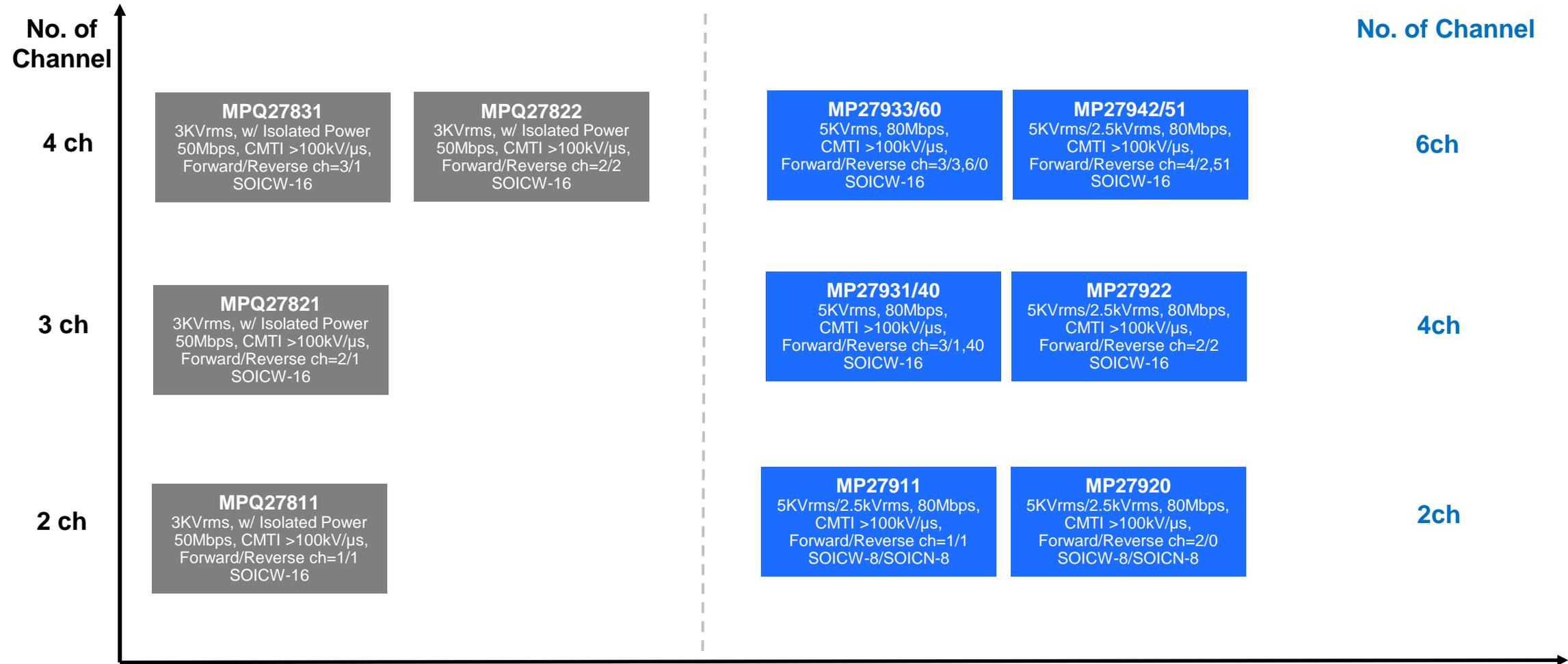
**MP18851**  
*Dual Independent Drivers*



**MP18871**  
*PWM Input HB*



# Digital logic/Isolator Roadmap



Digital Isolator+ Isolated Power

Digital Isolator

Sampling

Released

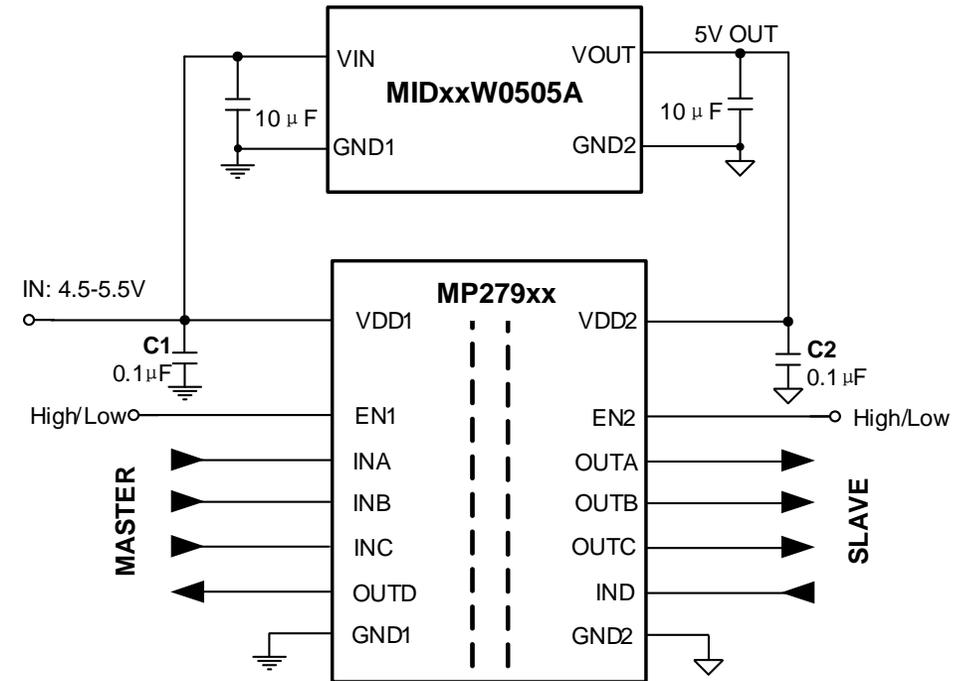


# MP279xx – 4~6 Channel digital isolator

## Key Features

- Wide Input Range: 2.5V-5.5V
- Up to 150Mbps Data Rate, 20Mbps option
- Ultra Low Power Supply Current
- High Electromagnetic Immunity
- $>\pm 100\text{kV}/\mu\text{s}$  Common-mode Transient Immunity
- 13ns Propagation Delay for 5V Operation
- 5kVrms Isolation
- Selectable Channel Direction
  - 4 channel (4/0, 3/1, 2/2)
  - 6 channel (6/0, 4/2, 3/3)
- Selectable Output Default Value
- Available in SOICW-16
- Applications: E-meter, Isolated ADC/DAC, Motor control, Industrial automation, SPI Isolation

## Typical Circuit

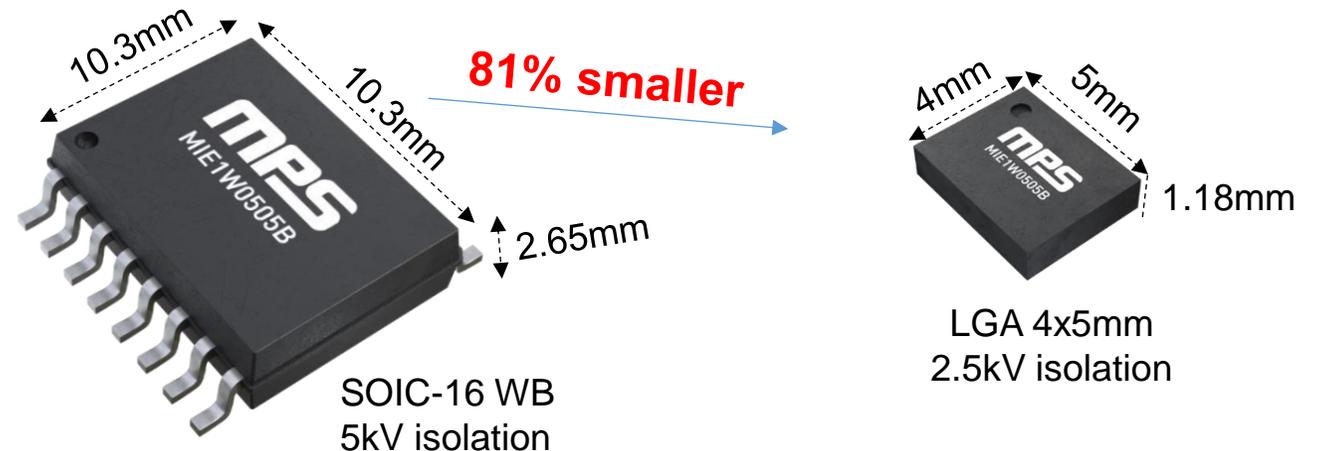
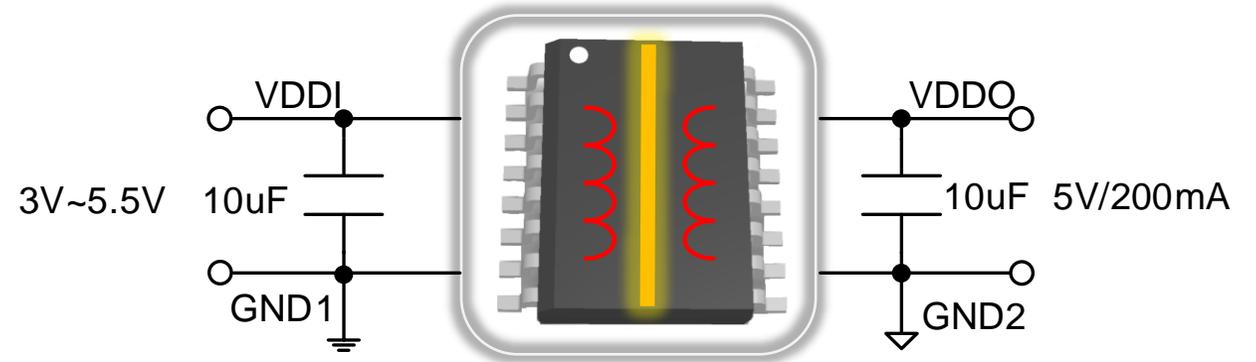


# MIE1W0505A- 5V to 5V Isolated Module

## Key Features:

- Input Range: 3V-5.5V
- 5V/3.3V Output Voltage
  - 5V → 5V or 5V → 3.3V >200mA (1W)
  - 3.3V → 3.3V >50mA (0.165 W)
- Excellent Load/Line Regulation Performance
- 1W Output Rating Option
- SCP, OCP, OTP Protection
- 5kVrms Isolation (SOIC-16 WB)
- 3kVrms Isolation (SOIC-8 WB)
- 2.5kVrms Isolation (Tiny LGA 4mmx5mm)
- Low Emission: meet CISPR 32 Class B
- Small SOICW-16 package, SOIC-8 WB
- **Tiny LGA 4x5mm package**
- Applications: BMS, Digital Isolator bias supply

## Typical Circuit

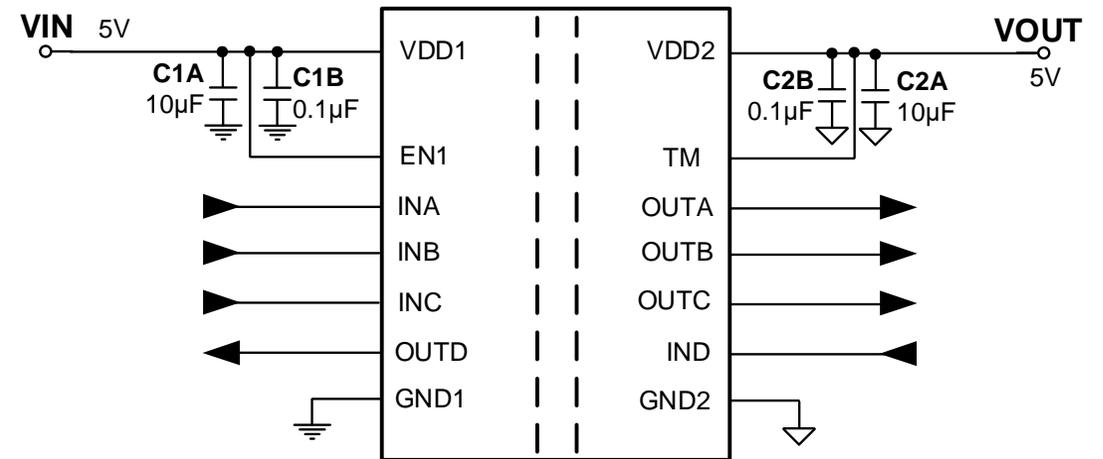


# MPQ278xx – 2-4 Ch digital isolator with Isolated Power

## Key Features

- Input Range: 4.5-5.5V
- Integrated 1W Isolated Power
- Up to 50Mbps Data Rate
- High Electromagnetic Immunity
- $>\pm 100\text{kV}/\mu\text{s}$  Common-mode Transient Immunity
- 3kVrms Isolation
- Selectable Channel Direction
- Selectable Output Default Value
- SCP, OCP, OTP Protection
- Available in SOICW-16 Packages
  
- Applications: Battery management systems (BMS), EV Charging Stations, Industrial Communication systems, Industrial automation/PLC

## Typical Circuit



Thank you