Battery Management Solutions

For High Cell Count Applications

Technology for Innovators™

TEXAS INSTRUMENTS

Agenda

- **TI's New Strategic Focus for Batteries**
  - **New Organization Targets New Markets**
- **Solutions for High Cell Count Devices**
  - **PowerLAN™ Family Overview**
- **Roadmap & Timing**
- **PowerPump™ Cell Balancing**
- **Summary & Wrap-Up**

TI's New Strategic Focus

Texas Instruments

Battery Management Solutions

NEW

High Cell Count & Emerging

Hand-Held

Notebook

✓ **Combining the POWERPRECISE acquisition with the best talent from TI's Battery Management Solutions**

✓ *Exclusively Focused on Key Markets & Product Segments:*

- *Power Tools, Automotive, UPS*

- *Industrial & Medical, Military*

- *Rechargeable, Primary and Hybrid Power Sources*

Battery Management Solutions

A Pervasive Set of Options

Battery Management for 2 to 16 Series Cells

- Multiple Architectures - Scalable & Stackable
    Protection Only or full ImpedanceTrack^{TM} Fuel Gauging
- Various Cell Balancing / Equalization Technologies
- Separate Analog to Digital Converters for Protection & Monitoring
- Complete Solutions Pre-Programmed or Individual Components
- Multiple Communications Options: SMBus, I^{2}C, SPI
- Advanced Algorithms for Today's Li-Ion Chemistries

Ideally Suited for Power Tools, Automotive, UPS, Industrial, Medical, & Military Devices

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Battery Management

PowerLAN^{TM} Product Families

bq76PL10x & bq78PL11x Stackable Monitors & Controllers
- Six parts - Same Architecture - Multiple System Configurations
- Components for Complete Measurement & Monitoring Systems
  - Vcell, Tcell, Istring & Impedance Track Fuel Gauging
- Advanced PowerPump^{TM} Cell Balancing - Efficient & No Heat
- Full SMBus Smart Battery Implementation or Simple Protection
- Scalable & Flexible for 2 to 16 Series Cells

bq77PL900 Single IC Monitor & Protector
- Protection & Analog Front End
  - Stand-Alone or Host Controlled Options
- Simple & Effective Cell Balancing
- Single IC Solution for 5 to 10 Series Cells

Stackable Battery Management

PowerLAN™ *bq76PL10x* & *bq78PL11x* Family

Components for a Complete Measurement & Protection System
- One IC Solution for 2, 3, 4 Series Cells
- Two IC Solution for 5 to 10 Series Cells
  - Three Different Stackable Parts: 2, 4, and 6-cell Monitors
- Measurement & Monitoring: Vcell, Tcell, Istring
  - Direct Protection High Side MOSFET Control
- Dedicated Measurement & Protection A/Ds
  - One A/D per Cell Voltage (1 mV Resolution, 5 mV Accuracy)
  - Two Separate A/Ds for Current Measurements & Safety
- PowerPump™ Cell Balancing – Works in Idle/Charge/Discharge
- SPI or SMBus/I²C for External Interface

Multiple Parts for Simple System Configuration
- *bq76PL102/104/106* Dual, Quad, & 6-Cell Stackable Monitors
- *bq77PL112/114* Gateway Controllers w/Dual or Quad Cell Monitors

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Product Details

bq76PL102/104/106 Dual, Quad, or 6-Cell Monitors

- Cell Monitors for use with *bq78PL11x* Gateway Controllers
- Measure Voltage & Multiple Temperatures for Each Series Cell
- Allows Synchronized Voltage Measurements with String Current
- Multiple Package/Size/Cell Count Options all Operate Identically
- Advanced PowerPump™ Cell Balancing with Auto-Shut-Off
- Multiple Balancing Algorithm Options: SOC or Voltage-based
- Operates Directly from Cells - No Special Power Requirements
- Low Current - Automatic Sleep Mode Between Measurements

Product Details

bq78PL112/114 Gateway Controllers

- Host Controller for use with *bq76PL10x* Cell Monitors

- Measures String Current & Lowest 2 or 4 Cells for V & T

- Synchronizes Cell Voltage Measurements with String Current

- Communicates with System: SMBus/I^{2}C or SPI

- Directly Drives Pack Protection MOSFETs
  - OV, UV, OT and Other Safety Threshold Fully Programmable

- Advanced Algorithm Calculations:
  - True Cell Impedance Measurements & Calculations
  - State-of-Charge and State-of-Health
  - Provides PowerPump^{TM} Cell Balancing Management

- **Can be used Stand-Alone for 2, 3, or 4 Series Cells**
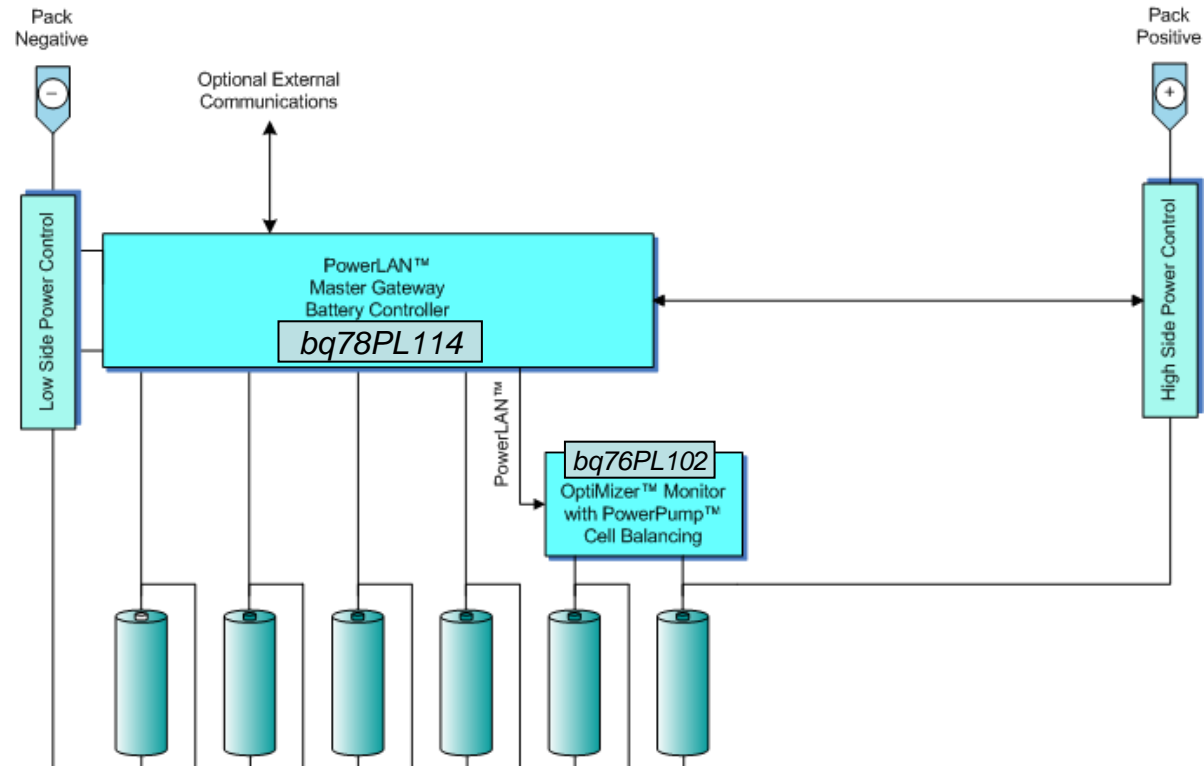
- Low-Drop Out Regulator for Support Circuitry

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System Overview: 6-Cell Solution

Full Fuel Gauging, Protection & Monitoring

- Single Chip Master *bq78PL114* supports lower 4 Cells
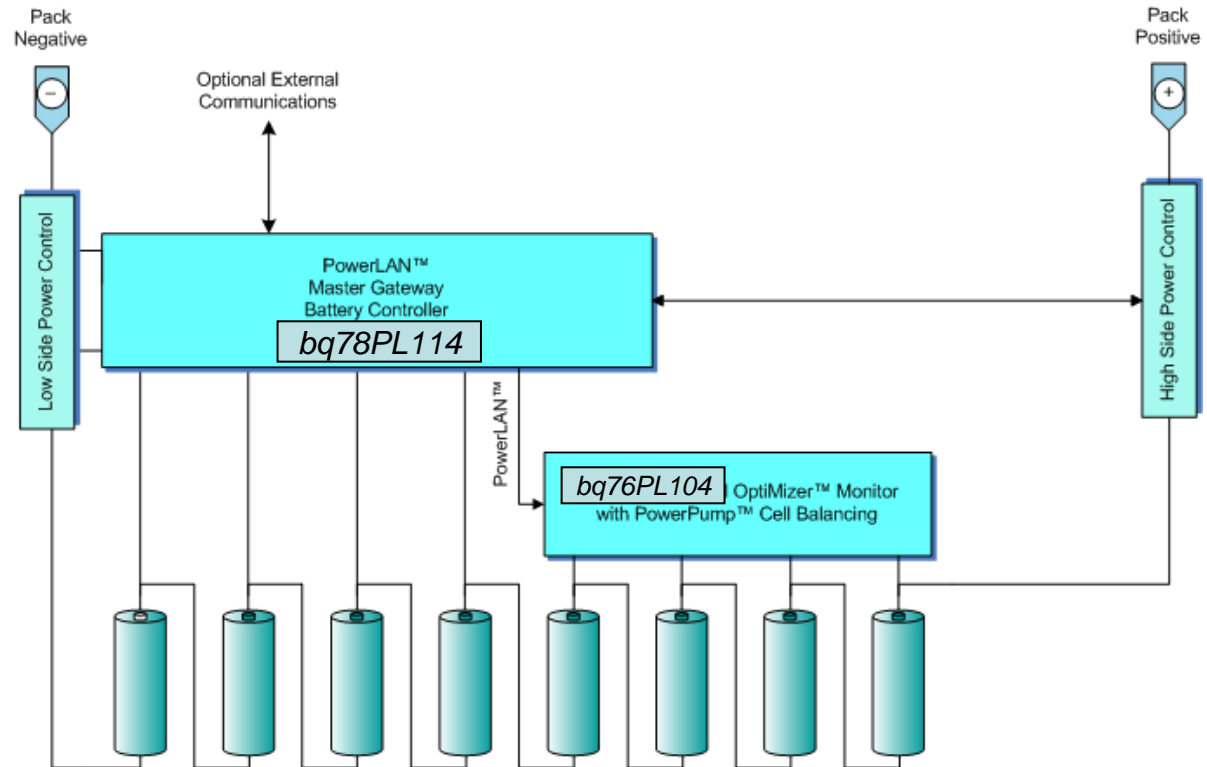
- With a *bq76PL102* extends to 6 cells

System Overview: 8-Cell Solution

Full Fuel Gauging, Protection & Monitoring

- Single Chip Master **bq78PL114** supports lower 4 Cells

- With a **bq76PL104** extends to 8 cells

System Overview: 10-Cell Solution

Full Fuel Gauging, Protection & Monitoring

- Single Chip Master *bq78PL114* supports lower 4 Cells

- With a *bq76PL106* extends to 10 cells
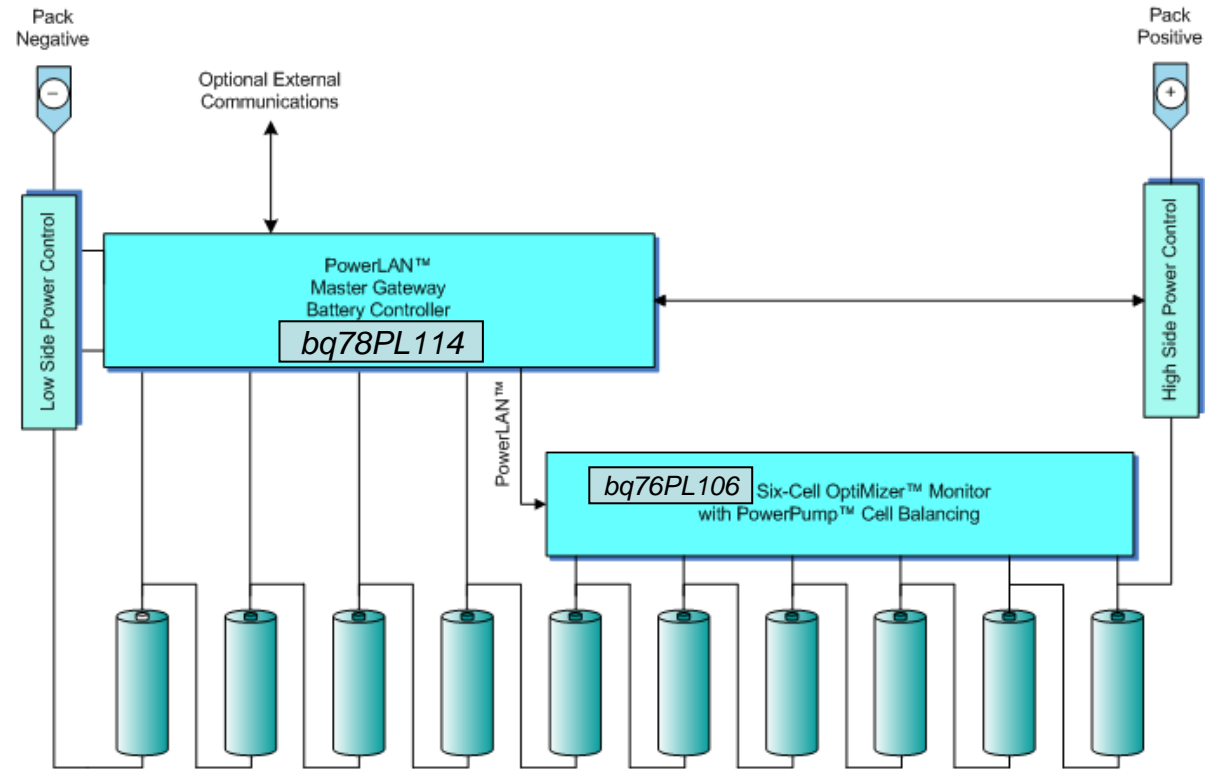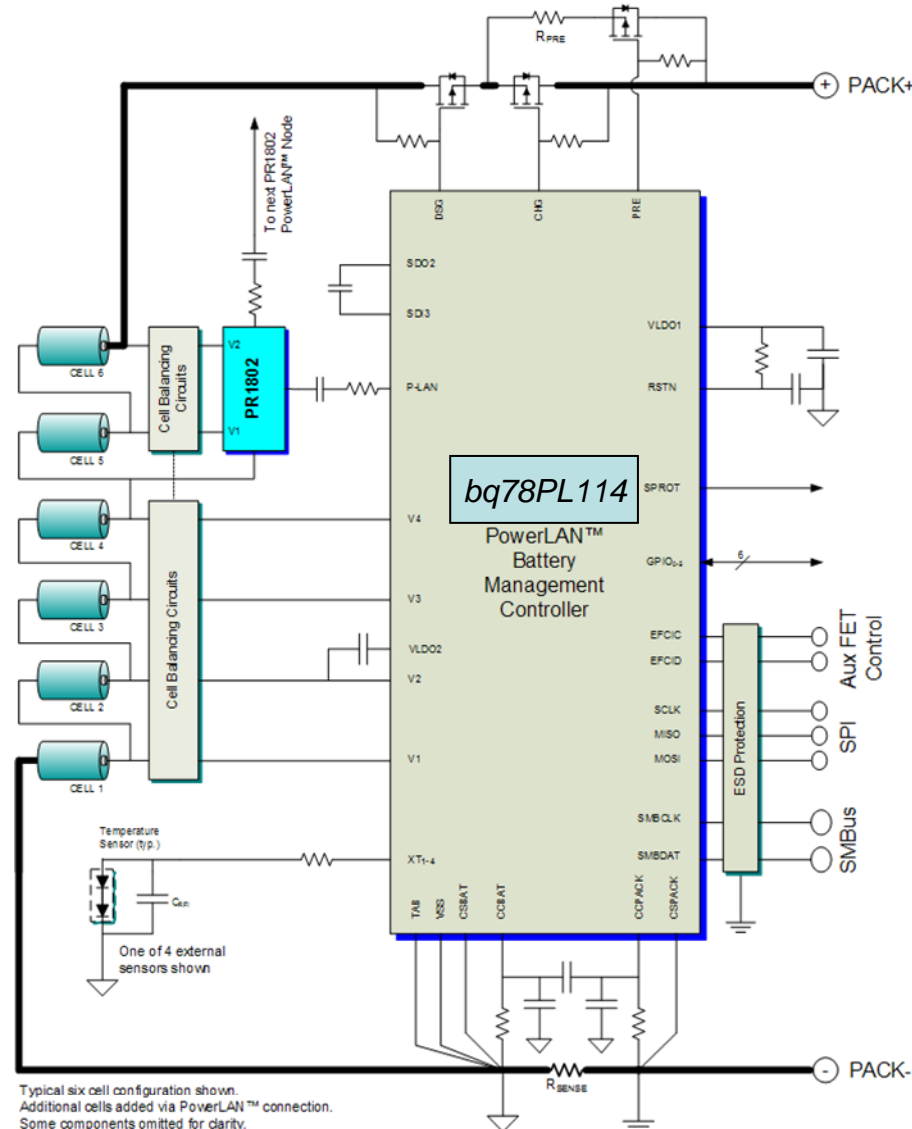
6-Cell Example Schematic

bq78PL114 Gateway Controller with Four Cell Monitor & PowerPump™ Cell Balancing

bq76PL102 Dual Cell Monitor with PowerPump™ Cell Balancing

- Optional SMBus, I²C, or SPI External Communications to System

Battery Management - Protection

PowerLAN™ *bq77PL9xx* Family

Low-Cost Protection & Measurement
- Single IC Solution for 4 to 10 Series Cells
- Simple Cell Balancing
- Multiplexed Analog-to-Digital Converter for Measurements
- Safety Comparators for Fast Response to OV, UV, OT
- I^{2}C External Interface (Host Mode only)
- Built in Low-Drop-Out Regulator

Single IC Option:
- *bq77PL900* Five to 10 Cell Precision Protector
  - Stand-Alone or Host Mode
    - I^{2}C Interface in Host Mode
  - High-side FET drive
  - Analog Front End for Precision Measurements
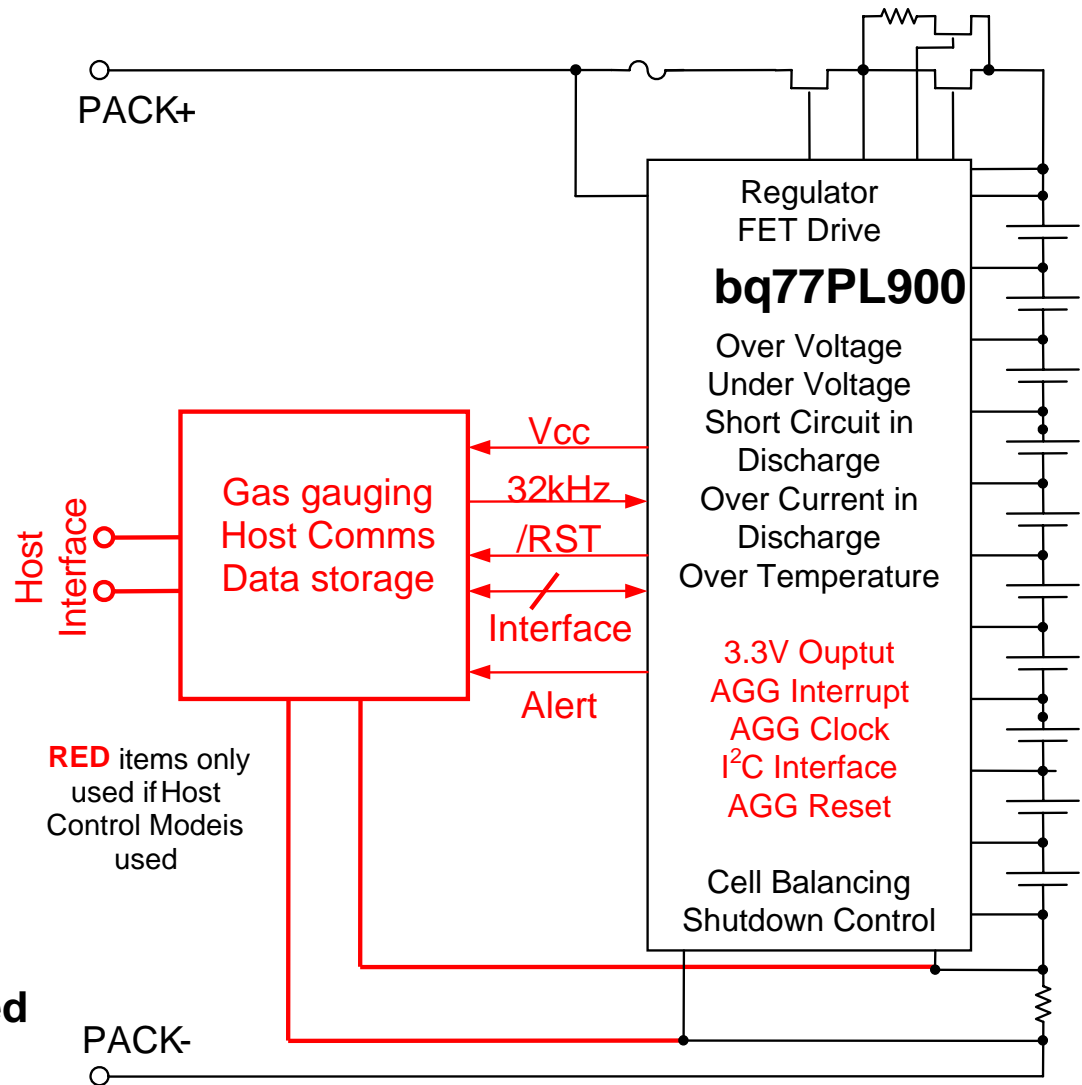- Additional Products in Development

bq77PL900
5 – 10 Cell Monitor & Protector

bq77PL900
5 – 10 Cell
Monitor & Protector

Features:

- **Vcell Measurement Output**
- **5 Volt, 25mA Regulator**
- **3.3 Volt, 25 mA Regulator**
- **OV, UV, OT Protection**
- **OC & SC Protection**
- **I²C Host Interface**
- **Simple Cell Balancing**
  - **Automatic or Host Driven**
- **High-side FETs**
- **50 V Maximum Vcc**
- **-20' to +85'C Operating**
- **Stand-Alone or Host Controlled**
    Operation

PACK+

Regulator
FET Drive

bq77PL900

Over Voltage
Under Voltage
Short Circuit in
Discharge
Over Current in
Discharge
Over Temperature

3.3V Ouptut
AGG Interrupt
AGG Clock
I²C Interface
AGG Reset

Cell Balancing
Shutdown Control

Host Interface

Gas gauging
Host Comms
Data storage

Vcc
32kHz
/RST
Interface
Alert

RED items only
used if Host
Control Mode is
used

PACK-

Roadmap & Timing

Product Roadmap

bq76/78PL1xx Stackable Monitor Family

- **bq76PL102/104** Dual & Quad Cell Monitors with PowerPump™ Cell Balancing
  - Samples 1Q-2008
- **bq78PL112/114** Gateway Controllers With Cell Monitors & PowerPump™ Cell Balancing
  - Samples 2Q-2008

bq77PL9xx Precision Protectors

- **bq77PL900** Five to 10 Cell Monitor & Precision Protector
  - Samples 1Q-2008 - Production 2Q-2008

PowerPump^{TM} Cell Balancing

Cell-to-Cell Energy Transfer: PowerPump^{TM}

- Efficient & Safe
- More Efficient that Bypass (Bleed) Balancing - No Heat
- True Equalization - Can Operate during Charge, Idle, or Discharge
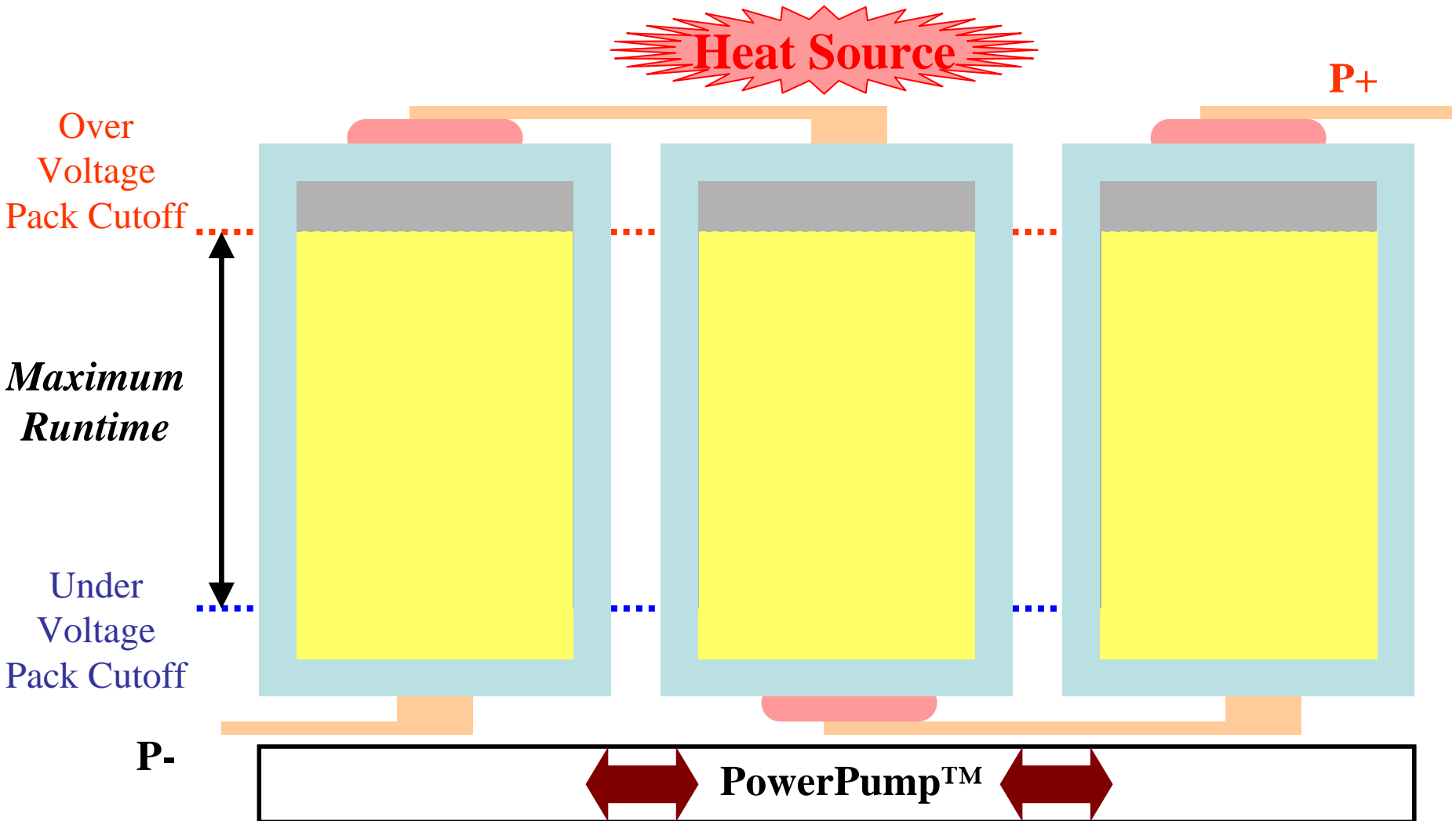
Why Cell Balancing?

- Prevents Cell Abuse
- Assures Proper and Safe Cell and Pack Charging
- Maximizes Useable Cycle Life and Runtime
- Detects and Diagnoses Cell Anomalies

PowerPump™ Cell Balancing
Maximum Runtime .... Every time

Heat Source

P+

Over Voltage Pack Cutoff

Maximum Runtime

Under Voltage Pack Cutoff

P-

PowerPump™

Summary & Wrap-Up

- **Summary & Wrap Up**

Next Steps