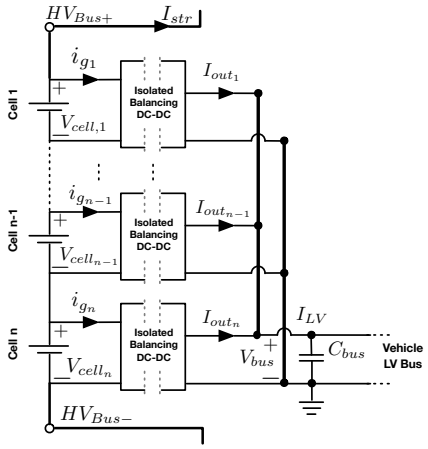
Active: Shared bus

- The primary problem with active balancing is its cost
- A new approach uses one small dc–dc converter per cell and a capacitive shared low-voltage bus to perform balancing[1]
- A "balancing metric" is mapped to a dc level between about 9 V and 14 V
- Principle of operation: Using controlled dc–dc converter
  - Transfer charge from low-voltage shared bus to cell if this cell's metric is below the shared-bus voltage
  - Transfer charge from cell to low-voltage shared bus bus if this cell's metric is above the shared-bus voltage

[1] M.M. Ur Rehman, M. Evzelman, K. Hathaway, R. Zane, G.L. Plett, K. Smith, E. Wood, and D. Maksimovic, "Modular Approach for Continuous Cell-level Balancing to Improve Performance of Large Battery Packs," ECCE 2014.

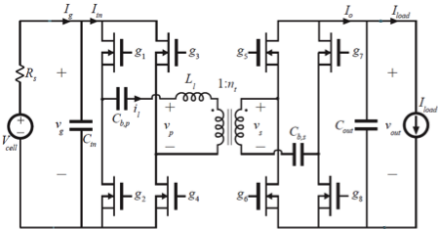
Topology and balancing metric



- Example topology shown
- Balancing metric might be cell SOC, voltage
- Might be designed to promote differential power processing, relatively increasing stress on "strong" vs. "weak" cells
  - Enhances life, and brings entire pack to homogeneous end-of-life
- Shared bus represents average metric-function value, brings metric of every cell into balance (not necessarily SOC)

Converter design; reduced cost

- Can power auxiliary loads from low-voltage bus: if load power is large and consistent enough, can replace bidirectional dc–dc converters with unidirectional converters
- Costs reduced by processing only small mismatch power between cells, and simplicity of modular structure with single isolated shared bus with no additional communications
- Can be cost-neutral (vs. passive) since can both balance and replace costly large dc–dc converter used to convert pack voltage to 12 vdc for vehicle accessories
- Reduced cooling needs



Dual-active-bridge dc–dc converter

Summary

- Active balancing requires circuitry and controls that are generally considered more expensive than passive balancing
- Shared-bus active balancing using dc–dc converters can achieve all benefits of active balancing: speed, energy efficiency, life extension by placing more stress on healthier cells
- But, since it can replace vehicle expensive high-voltage to 12 V dc–dc converter as well as balance, net cost for vehicle can be cost-neutral
- Cooling system can be smaller, less expensive
- Very promising method for future balancing systems

Credits

Credits for photos in this lesson

- Thanks to Prof. M. Scott Trimboli for the drawing of the converter topology on Slide 2