TI Innovation Day France 2010

La gestion de puissance d'énergie et la sécurité dans le véhicule électrique du futur

Battery Monitoring

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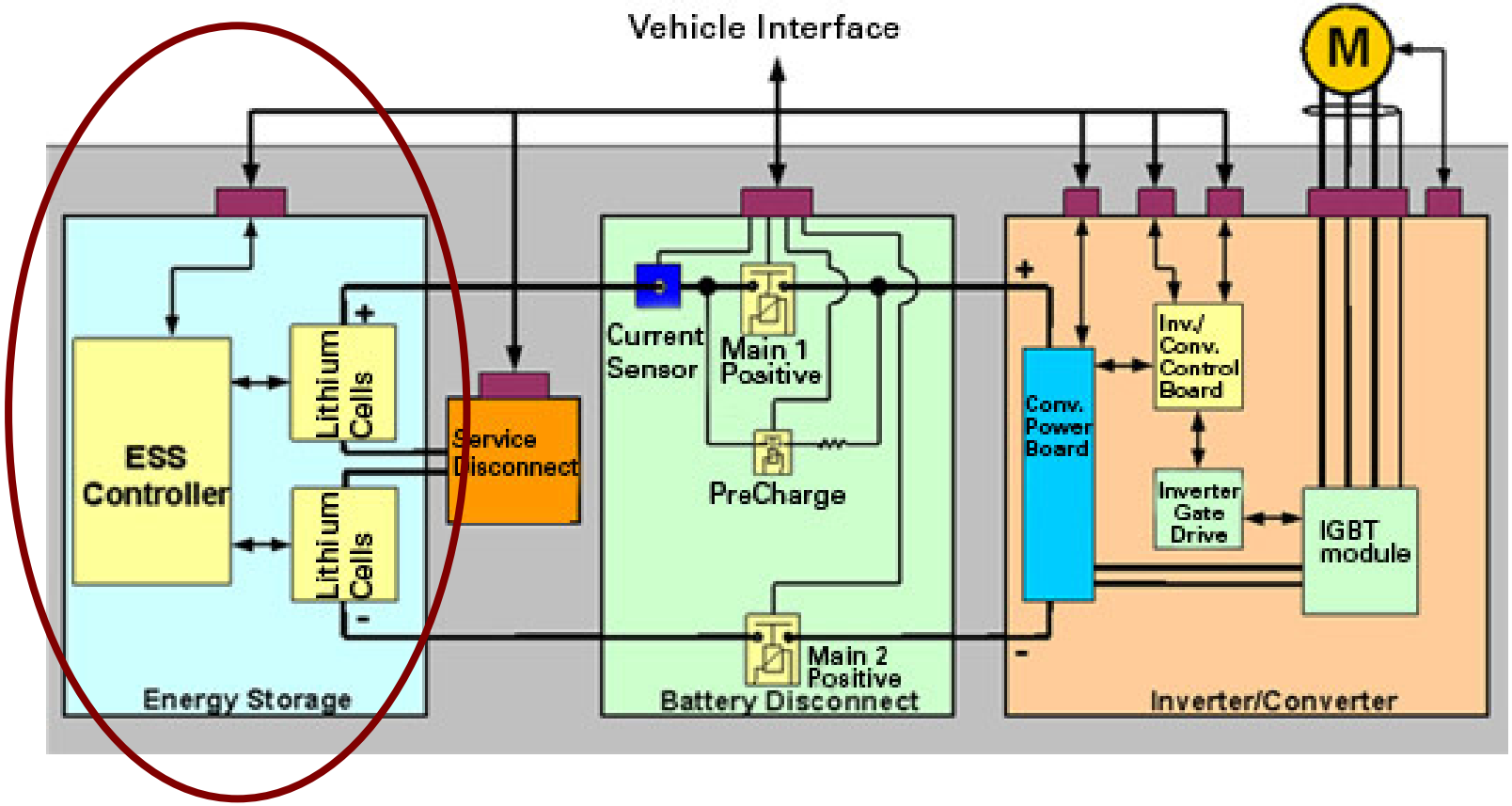
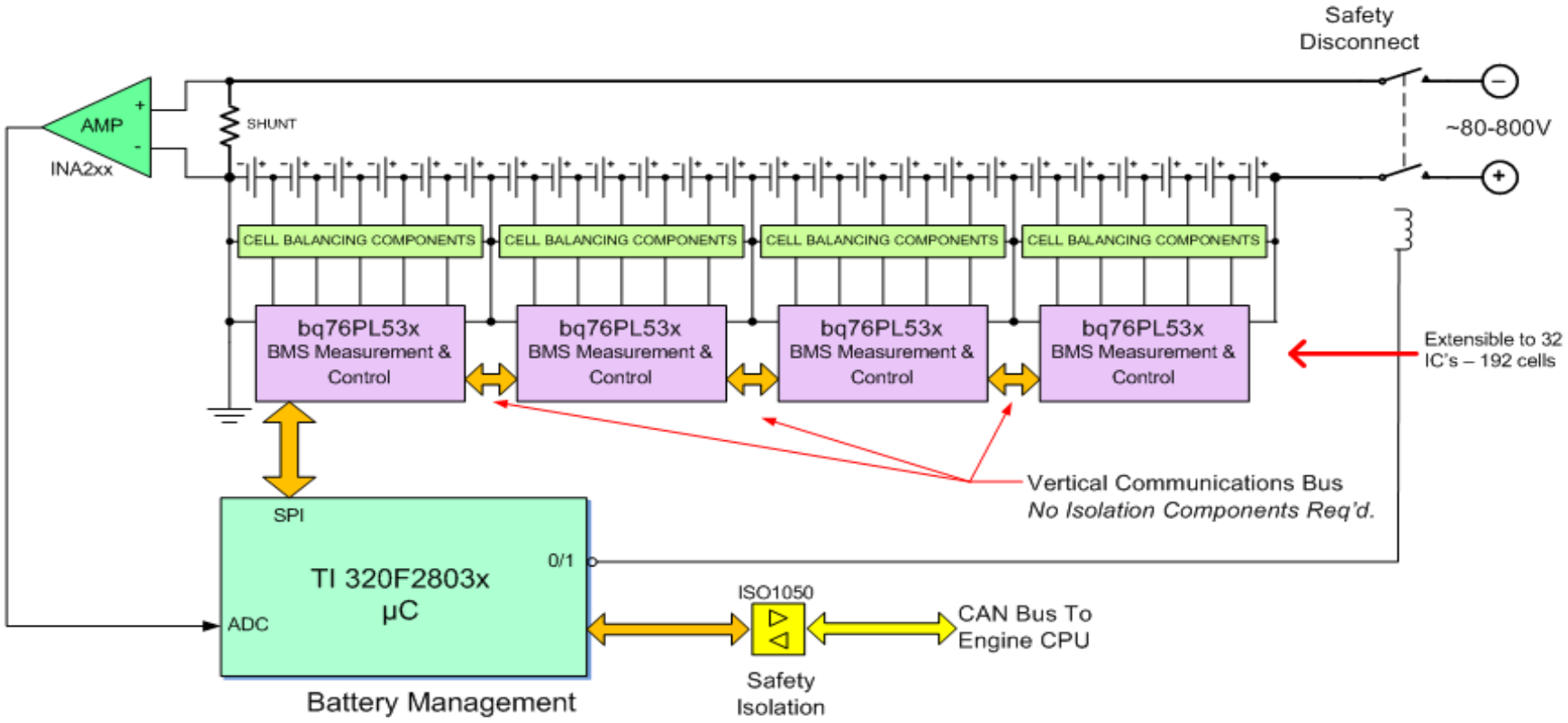
Texas Instruments

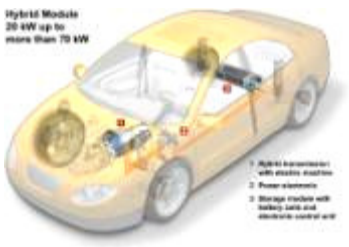
EV Li-Ion System Example

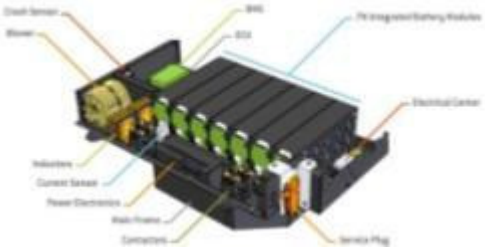


Typical Battery Management System



TI HEV/EV Battery Management Systems Solutions





bq77PL660
2nd Protector

Protector
Protector

CELL BALANCING COMPONENTS
CELL BALANCING COMPONENTS
CELL BALANCING COMPONENTS
CELL BALANCING COMPONENTS

Monitor & Balancer
Monitor & Balancer
Monitor & Balancer
Monitor & Balancer

Vertical Communications Bus
No Isolation Components Required

bq76PL536
bq76PL600
Monitor
Balancing

SPI

BMS Controller TMSx70 or C2000

SPI

2

Pre-Charge Relay (Optional)
Safety Disconnect Relay (Contactor)

V
V
A
INAxxx
Pack Monitor

LOAD

100µ? SHUNT

Safety Disconnect Relay (Contactor)

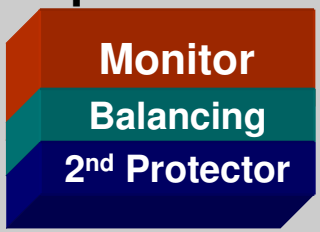
CAN

ISO72xx Safety Isolation

ISO74xx
Isolator

Automotive Products: Up to 192 Series Cells

bq76PL536

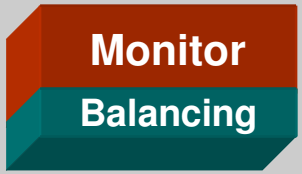


HEV / EV Monitor & Protector with Balancing

- 3-6 Cells
- All-in-One Design
- 6usec SAR ADC
- 2 Temp Monitors
- 1 Aux Voltage
- 1 Brick Voltage
- Integrated OV/UV & OT Comparators
- Hardware FAULT signaling
- Bleed Balancing
- Fast 1Mb/s SPI
- 64 TQFP

Available Now

PowerPump™ Demo Platform



HEV / EV Monitor & Balancing (bq76PL537)

- 3-6 Cells
- Parallel 13 channel (Δ-Σ) ADC
- 2.5ms to 80ms simultaneous conversion
- 6 Aux/Temps
- 1 V_{BAT} Voltage
- Active Charge-Transfer Balancing
- Flexible ADC Acquisition Window for Precise Z Measurement
- Fast 1Mb/s SPI
- Sampling No

Demo Board

2011 Developments

bq76PL600

Gen II HEV / EV Monitor & Balancer

- 6 -12 Cells
- Parallel (Δ-Σ) ADC
- Aux/Temps
- 1 Brick V
- 500us conversion
- Active DC/DC or Bleed Balancing
- Differential Comms
- Built in self-test for ISO26262 Compatibility
- Open-wire Detect
- Works with PL660 for enhanced system-level test
- Q100 (-40 to 105C)
- 64 TQFP

bq77PL660

Secondary Protector

- 4-12 Cells
- Comparators for:
  - Over-Voltage
  - Under-Voltage
  - Over-Temperature
- Heart-beat Loop + Direct Logic Signal
- False-Alarm Filter
- Strong self-test
- Programmable set points – resistor/capacitor
- Open-wire Detect
- Q100 (-40 to +105C)
- 32 TSSOP footprint

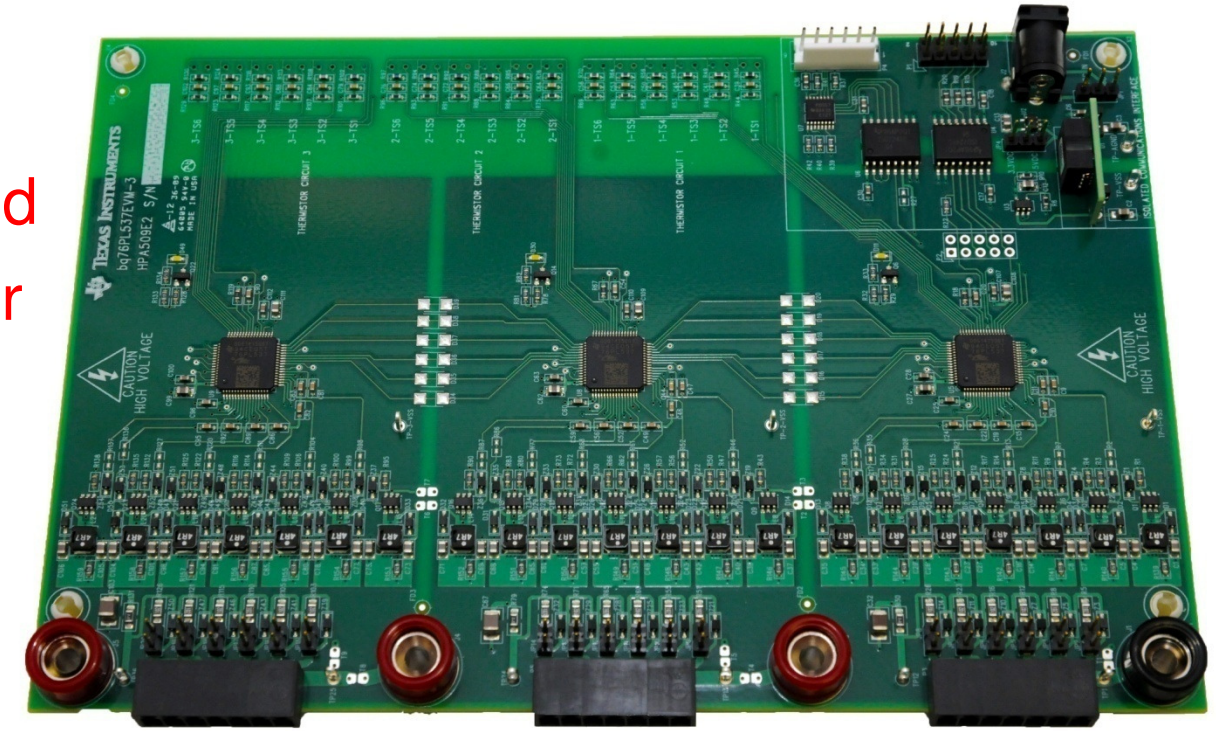
ES 2Q11

PowerPump™ *Active* Balancing Demo Platform

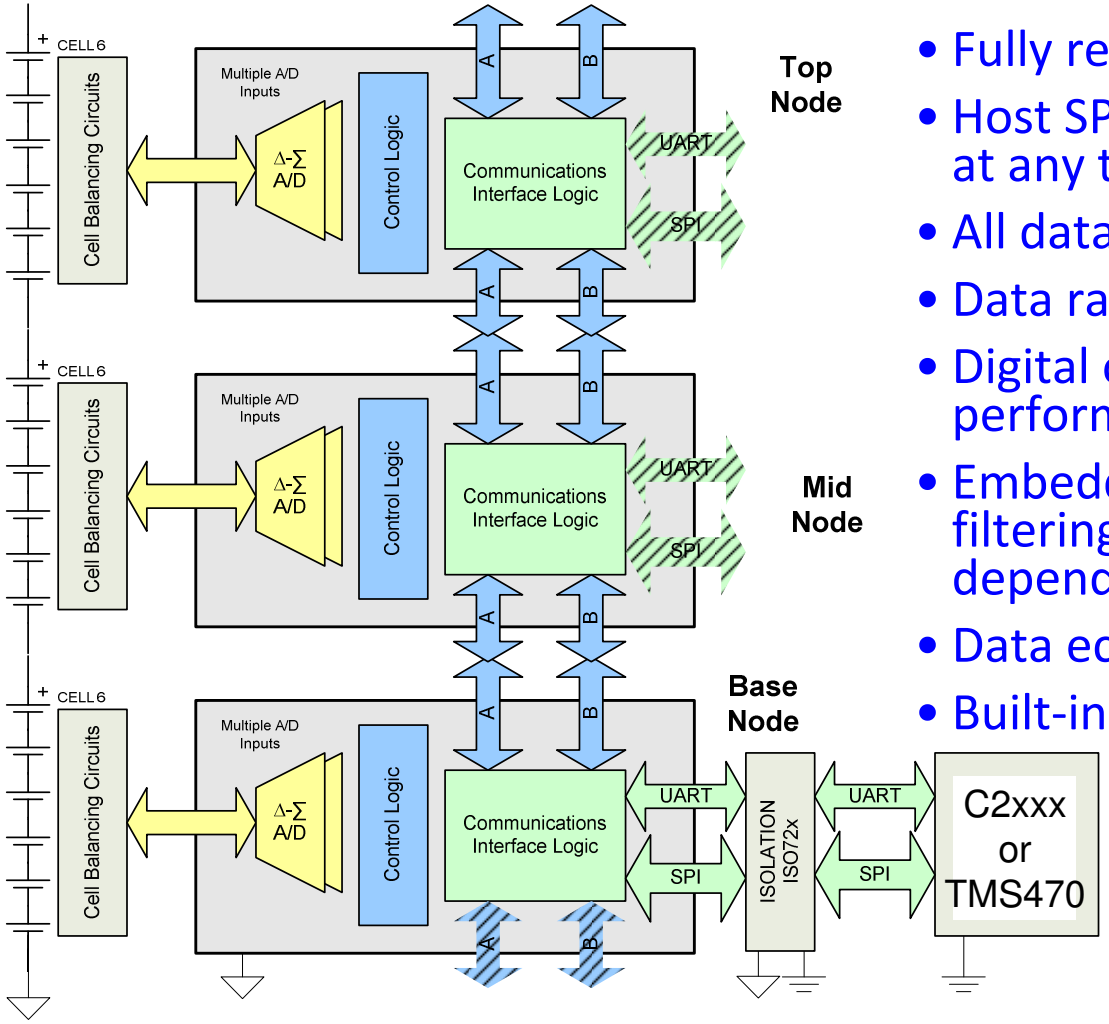
bq76PL537

bq76PL537 Evaluation Modules

- 3-IC stack
- ~200mA balancing-current available now
- 2A version planned
- Works with cells or power supplies
- 2.5KV Isolation
- PC interface and Windows® development software included

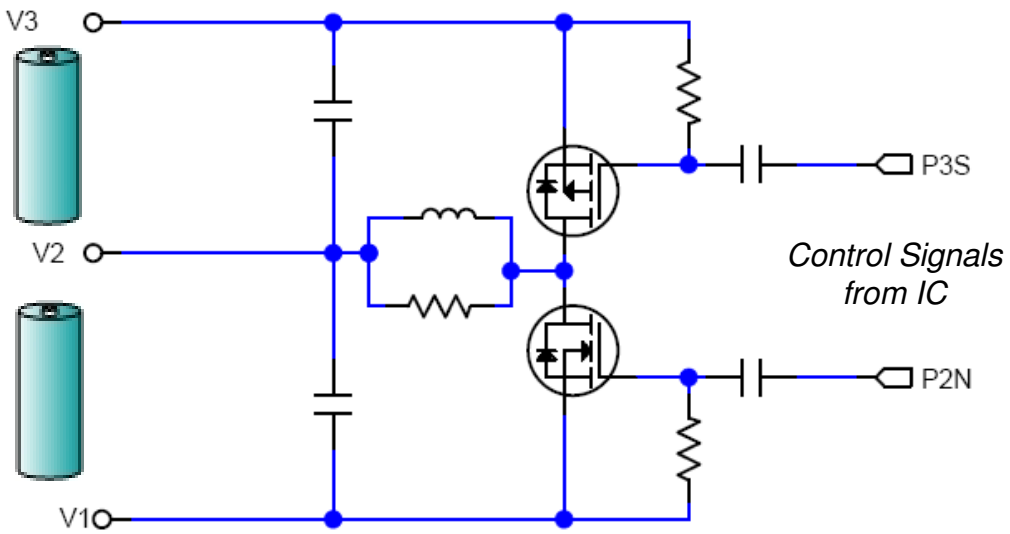


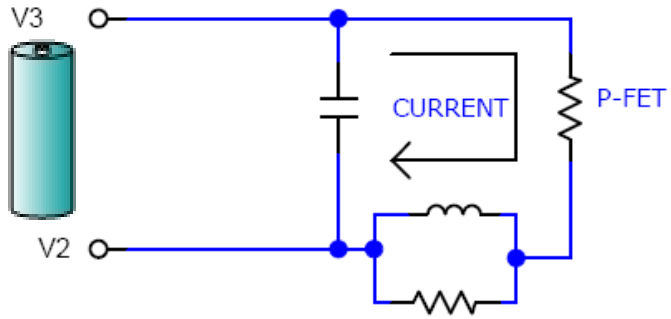
bq76PL537 **Advanced Communications**



- Enhanced communications reliability
- Fully redundant – dual channels
- Host SPI or UART can swap to A or B bus at any time
- All data re-generated at each node
- Data rate independent of number of IC's
- Digital oversampling filters for EMC performance
- Embedded-clock vertical bus permits filtering, removes clock-data timing dependencies
- Data echoed back to Host for verification
- Built-in CRC checking

PowerPump™ Operation





- Example: Pumping from Cell 3 →Cell 2
  - P3S frequency is 200 kHz, 33% positive Duty Cycle
  - P3S Turns PFET ON
  - $\Delta I/\Delta T = V/L$: Energy in Inductor builds

PowerPump™ Advanced Cell Balancing

Cell-to-Cell Energy Transfer: PowerPump™

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

Real-Time Cell Balancing

- Prevents Cell Abuse
- Assures Proper and Safe Cell and Pack Charging
- Maximizes Useable Cycle Life and Runtime
- Up to 2A balancing current (equivalent to ~3.2A bleed)

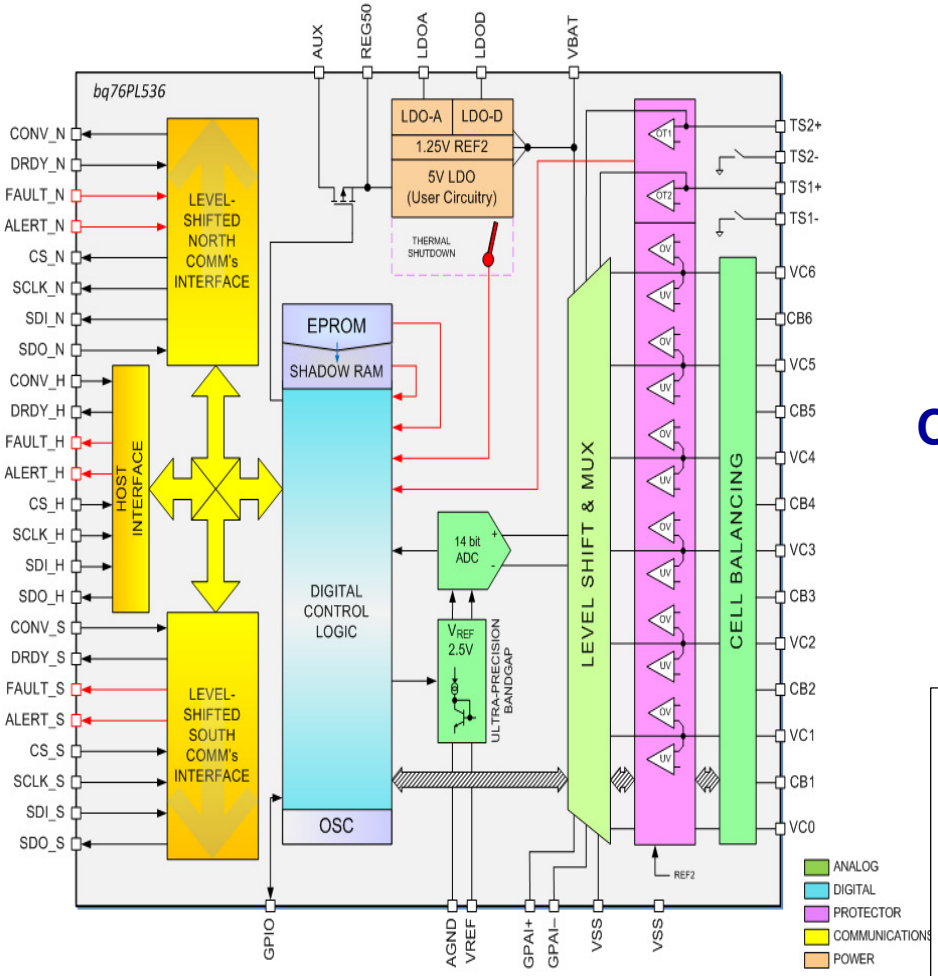
Li-ion Cell Balancing Goals
Automotive Applications

- Two different Balancing requirements
  - HEV - Compensate for SOC drift, e.g. due to self leakage and IC current draw mismatch
  - BEV - Compensate for capacity divergence and release stranded energy

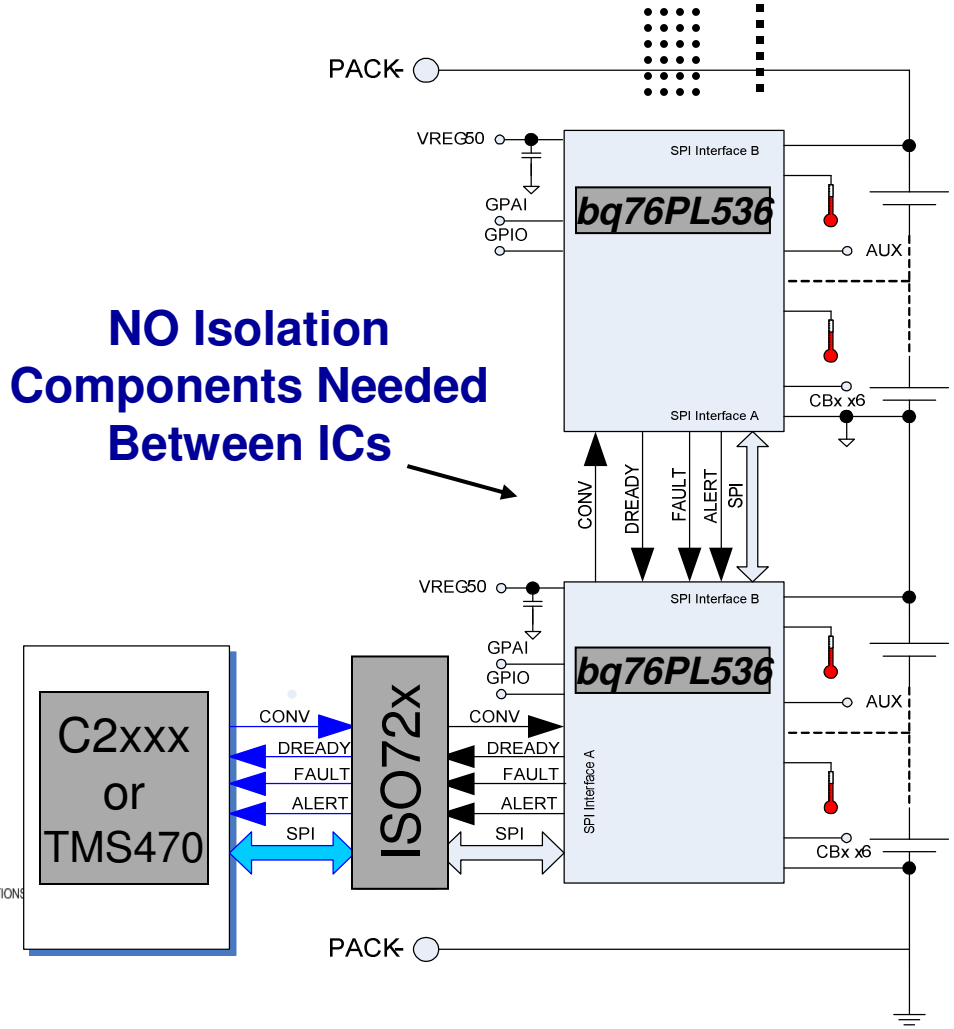
- HEV
  - Can be achieved with either bleed or active balancing
  - 100mA – 200mA capability
  - Cost Tradeoff must include heat release & cost of removing heat from bleed balancing
  - see simulation to compare heat release

- BEV
  - Battery Capacity 10x vs HEV
  - Capacity mismatch results in stranded energy towards end of discharge
  - Release of stranded energy can only be achieved with active balancing
  - Increases effective capacity towards end of life (or extends cycle life)
  - No benefit from Bleed balancing
  - Up to 2A capability

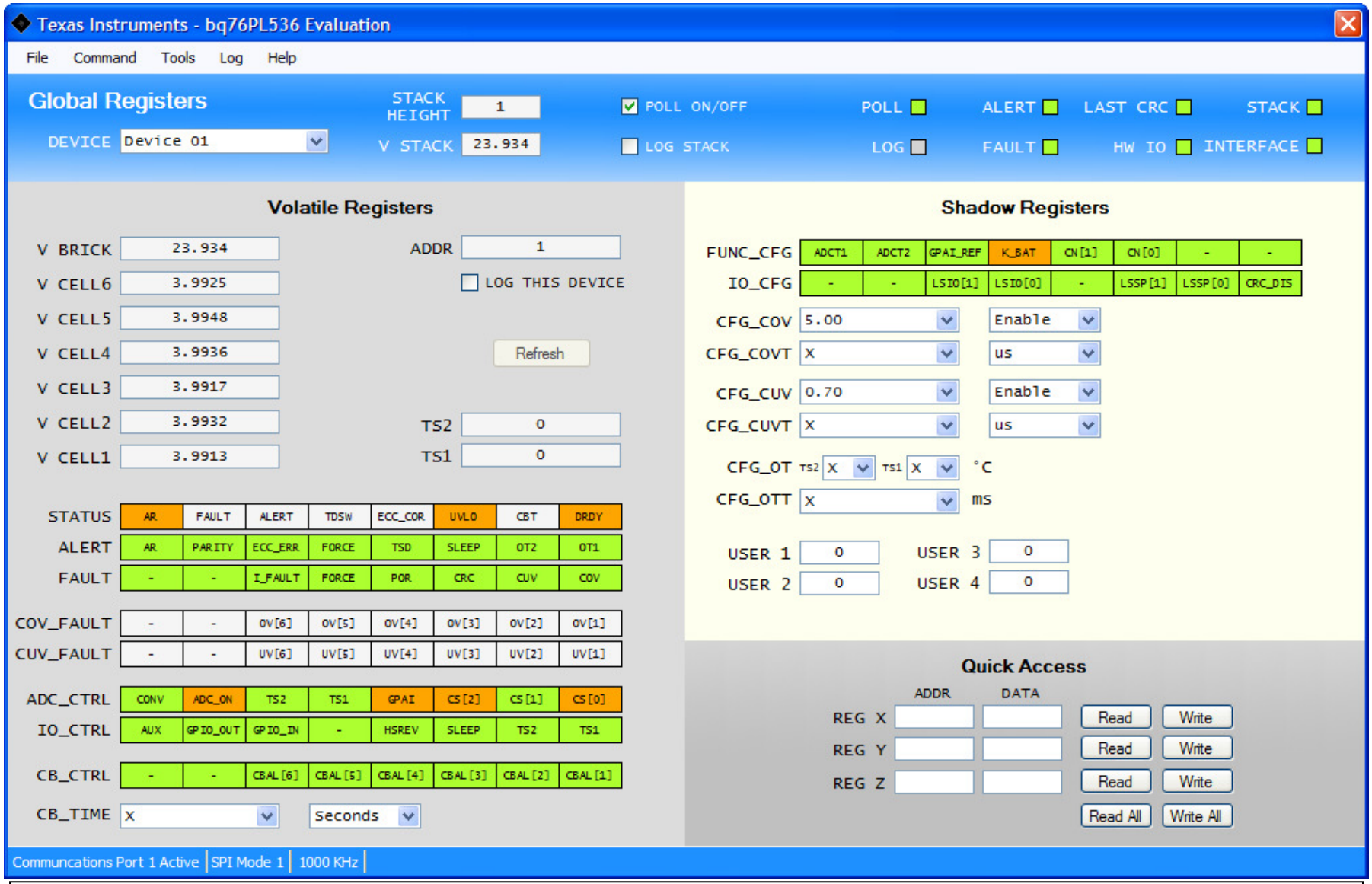
HEV Battery Solution: bq76PL536



NO Isolation Components Needed Between ICs

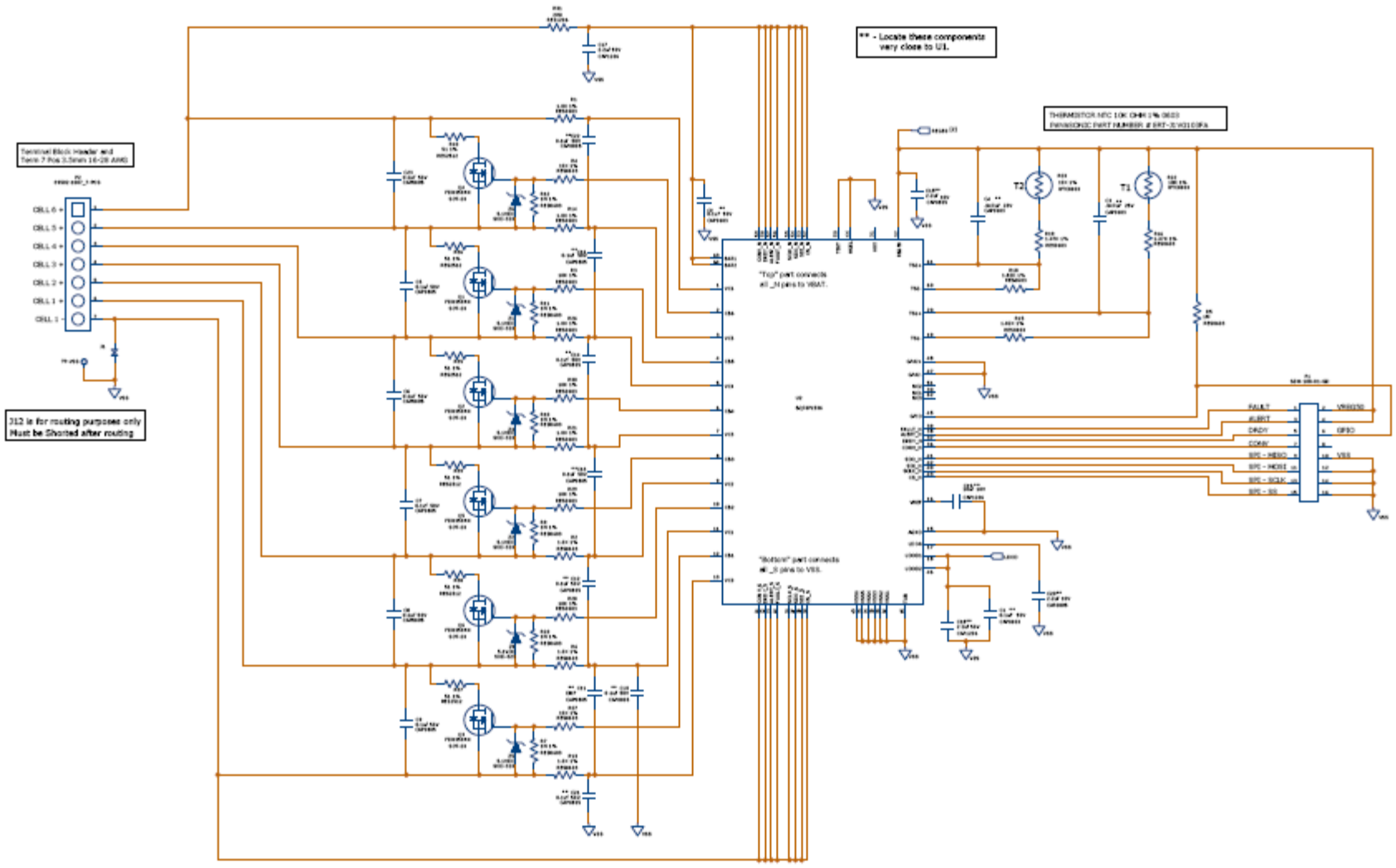


Evaluation Board Software



Texas Instruments

bq76PL536 Typical Schematic



Now the demo with bq76PL537

Thank You