

# Welcome!

## Texas Instruments New Product Update

- This webinar will be recorded and available at [www.ti.com/npu](http://www.ti.com/npu)
- Phone lines will be muted
- Please post questions in the chat or contact your sales person or field applications engineer



# New high cell count monitors and protectors for industrial applications

New Product Update Webinar

03/04/2021

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# Agenda

- Key devices in battery packs for industrial applications: monitor, gauge, protection IC
- Monitoring & protection basics
- Latest TI industrial monitors & protection ICs:
  - Monitors: BQ76942, BQ769142, BQ76952
  - Protection IC: BQ77216
- Key online resources

# What's in a battery pack?

- Batteries are being integrated into an ever-growing range of industrial applications, from vacuum cleaners to power tools to e-bikes to electric vehicles.
- Gauging, monitoring and protection of these batteries is important for a variety of reasons:
  - Most importantly, to maintain safe operation of the battery pack and the appliance under a wide range of environmental conditions.
  - To meet regulatory requirements imposed by authorities, customers, or internal quality control.
  - To maintain and extend the life of the battery in the application.
  - To communicate the capacity left in the battery, the health status of the battery.
  - To optimize the operation of the appliance based on the battery condition or performance.



# Battery electronics options

FOCUS for today

## Protector

- Simple hardware-based protection to respond to unsafe conditions like overvoltage, undervoltage, overcurrent, overtemperature, under temperature, overcurrent or short circuit

**Lowest complexity**

## Monitor

- Measures individual cell voltages
- Measures current (coulomb counting)
- Measures die temperature and external thermistors
- Cell balancing to extend battery run-time and battery life
- Protections with flexible thresholds
- Communicates data and status to MCU or stand-alone gauge

**Highest flexibility**

## Gauge

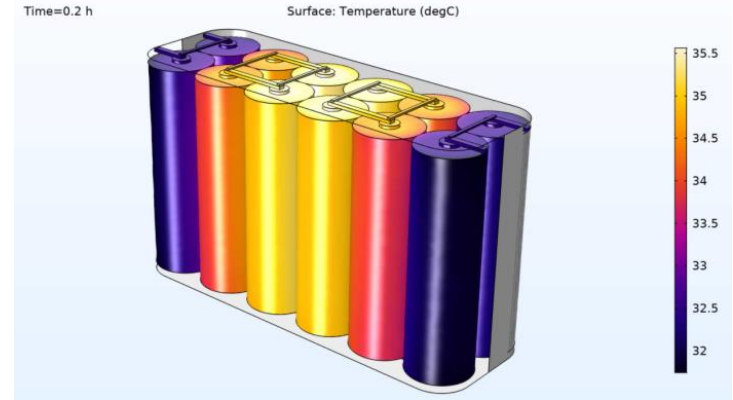
- Reports capacity, run time, state of charge
- Enhanced protections
- Black box features to diagnose battery failure
- Extends run time of battery due to accurately determining how much capacity is remaining
- Extends lifetime by dynamically controlling healthy, safe, fast charging
- Authentication, state of health, traceability... (also **available as a stand-alone IC**)

**Highest integration**



# Battery monitoring and protection basics

- **Temperature monitoring and protection**
  - Temperature is typically monitored using one or more thermistors attached to the battery pack, at locations selected for the hottest point(s) on the pack.
  - The thermistor is biased at periodic intervals and compared against thresholds to identify an overtemperature or undertemperature condition.
  - If the temperature exceeds the allowed range for a programmed delay time, the protective action is initiated.
- **A quick side note: gauging**
  - Accurate voltage, current & temperature monitoring are key for reporting gauging information (i.e., state-of-charge, state-of-health) to your system on a gauge or MCU.

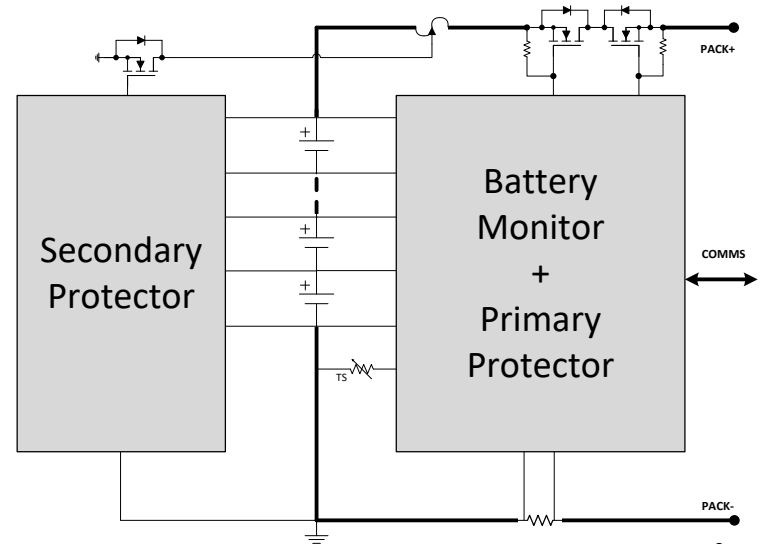


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# Battery monitoring and protection basics

## Redundancy for safety

- If a critical safety function (such as a comparator checking for cell overvoltage) malfunctions, the pack may overcharge and result in a dangerous event.
- To minimize this likelihood, many systems incorporate redundancy to make the system robust against a single point of failure. This redundancy is mandated by many regulatory standards.
- For example, a battery pack may integrate a monitor AFE which provides primary protection, together with a separate protector device for secondary protection.
- The primary protection is generally recoverable and is set to trigger at more aggressive limits.
- The secondary protection is usually not recoverable, is set to more extreme thresholds, and will permanently disable the pack when triggered.





# Monitor & Protection ICs – Portfolio Update

## BQ769x0

### **3-15s Monitor + Prot. + Gate Driver**

Up to 5V/cell w/ 10mV accuracy

Dedicated CC

Protections: OV, UV, OCD, SCD

Cell Balancing FETs: 5mA

Integrated low-side CHG and DSG drivers

Integrated LDO 2.5/3.3V (20 mA)

BQ76920: 3-5s; 20p TSSOP 4.4x6.5x1.2

BQ76930: 6-10s; 30p TSSOP 4.4x7.8x1.2

BQ76940: 11-15s; 30p TSSOP 4.4x7.8x1.2

**In Mass Production**

## Monitors

## BQ769x2

**NEW**

### **3-16S Monitor + Prot. + Gate Driver**

**Autonomous operation** and fault recovery

Supports random cell attach

Up to **5.5V/cell w/ 5mV accuracy**

Dedicated CC

Protections: OV, UV, OCD, SCD, **OW, OT, UT**

Cell Balancing FETs: up to **100mA**

Integrated **high-side CHG/DSG drivers**

**Two integrated LDOs 2.5/3.3/5V (45 mA each)**

BQ76942: 3s-10s; 48p TQFP 7x7x1

BQ769142: 3s-14s; 48p TQFP 7x7x1

BQ76952: 3s-16s; 48p TQFP 7x7x1

**in Mass Production**

## BQ771800

### **2-5S OVP**

Low power: 1 $\mu$ A

3.85V to 4.6V OVP

Accuracy:  $\pm$ 10mV (typ)

Internal Noise Filter

8p SON 3x4x0.75

**In Mass Production**

## Protectors

## BQ772xx

**NEW**

### **6S-16S Secondary Protection**

**Support up to 16s**

Low power: 1 $\mu$ A

**Open-wire detection (OW)**

**Temp Prot.: OTC, UTC, OTD, UTD**

**3.55 to 5.1V OVP ; 1.0V to 3.5V UVP**

Accuracy:  $\pm$ 10mV (typ)

Drive Fuse Blow or Back-to-Back FETs

**Active high and Active low output options**

BQ77216: 11-16s; 24p TSSOP 4.4x7.8x1.2

**In Mass Production**

# Battery monitor features

BQ76952 / BQ76942 / BQ769142

## Monitoring

- Digital voltage, current, and temperature measurements, integrated coulomb counter.

## Protections

- Primary protection for OV, UV, OTC, OTD, UTC, UTD, OTF, OW, SCD, OCD1,2,3, OCC, cell balancing, watchdog, and more. Integrated secondary protection.

## FET Drivers

- Integrated charge pump & drivers for high-side protection NFETs.

## Cell Balancing

- Integrated passive cell balancing up to 50mA, support for external passive balancing.

## Prechg / Predsg

- Support for high-side PFET-based precharge and predischage modes.

## Integrated LDOs

- Two programmable LDOs (external BJT) programmable to 5V / 3.3V / 3.0V / 2.5V / 1.8V, up to 45mA each.

## Communications

- Support for I2C, HDQ, SPI in all products

## High Voltage Tolerance

- High voltage tolerance of 85V

# Battery monitor features

## Example using the BQ76952

### Secondary protection

Works with external secondary protector

### Integrated CB FETs

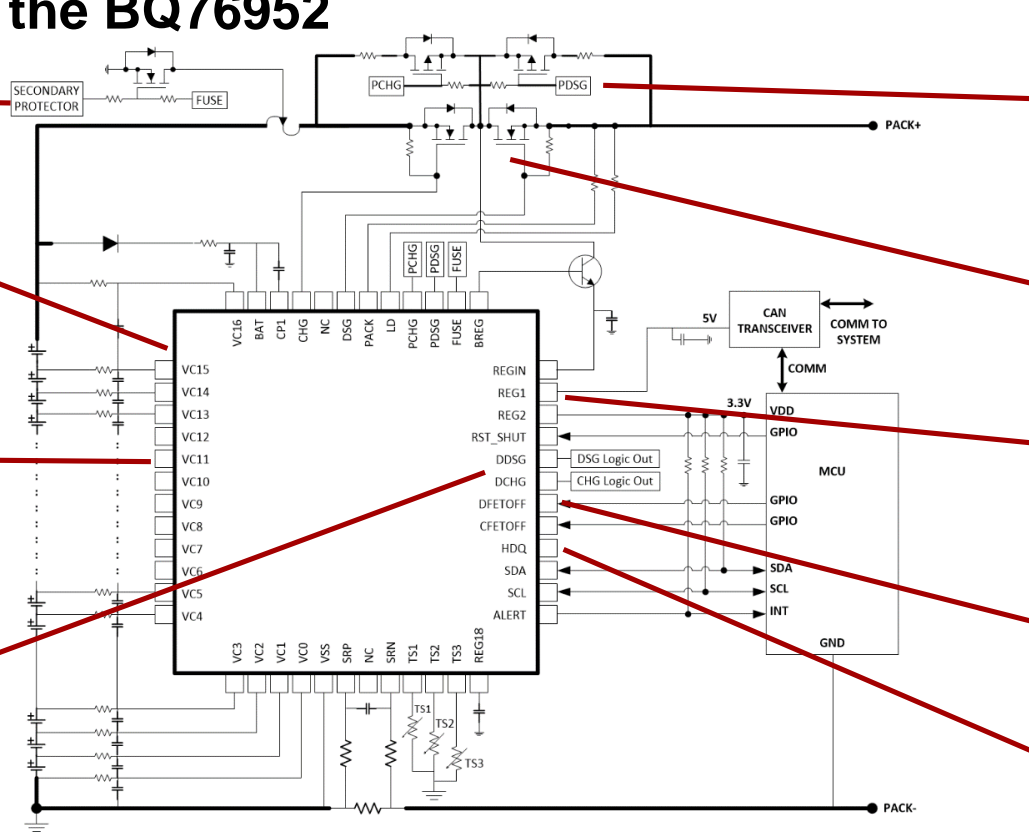
Up to 50mA CB current, autonomous or manual modes supported

### Random cell attach order

High voltage tolerance on cell input pins

### Digital CHG and DSG output

Can be used as alternative charge/discharge fault signal



### Integrated PFET drivers

Precharge and predischage support (to slowly charge-up a capacitive load at system startup)

### Integrated high-side NFET drivers

Programmable REG1 and REG2 (1.8V / 2.5V / 3.0V / 3.3V / 5V) e.g., to power CAN transceiver or MCU

External HW shutdown or reset control and fast FETOFF control

I2C or SPI or HDQ

# BQ76952

## 3S-16S battery monitor with high-side FET drivers & standalone protection

### Features

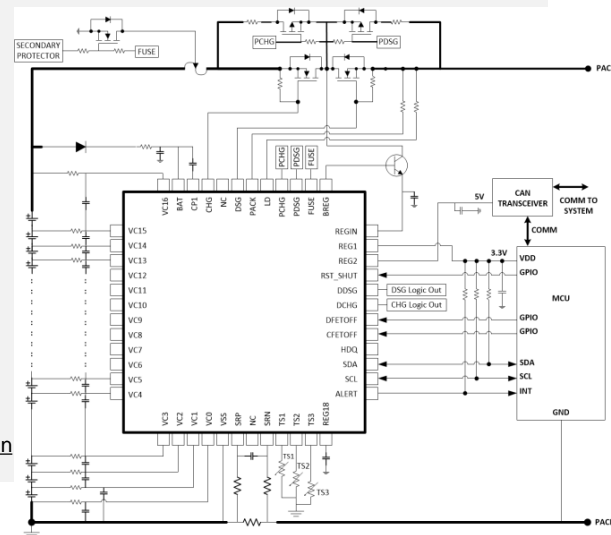
- **Digital V/I/T data** with 16/24-bit ADC and 16/24-bit Coulomb Counter
- **Fast data refresh rate:** all cells measured every 63ms, current every 3ms
- **Integrated high side nFET driver** with <10us DSG turnoff
- **Precharge and predischage modes** supported with external pFETs
- **High voltage accuracy** with optional calibration support
  - +/-5mV(typ), +/-10mV from 0~60degC
- **Standalone Mode** with full built-in protector or **MCU Mode** for host control
  - Voltage: OV / UV / OW / cell imbalance
  - Current: SCD/ OCD1,2,3 / OCC
  - Temperature: OTC / OTD / UTC / UTD / OTF
- **Flexible communication options:** I2C w/CRC, SPI w/CRC, HDQ
- **Secondary protection** can disable FETs or blow an in-line fuse
- **Autonomous cell balancing** option
- **Dual Programmable LDOs:** Output 1.8V to 5.0V, up to 45mA each
- **Low Power Modes:**
  - **SLEEP** (DSG FET + LDO on, periodic protections): **24 to 41uA**
  - **DEEPSLEEP** (LDO on, both FETs off): **9 to 10uA**
  - **SHUTDOWN** (all functionality off): **1uA**
- Package: 48-pin TQFP

### Applications

- Energy storage systems
- Garden tools
- E-bike, E-scooter, LEV

### Benefits

- **Solution Cost Saving** with highly integrated features
  - Save an external level shifter/driver w/ integrated HS driver
  - Reduce MCU code w/ Standalone Mode + autonomous CB
  - Save an external LDO w/ high loading integrated LDO support
- **Maximize cell capacity** with high voltage measurement accuracy
  - Further accuracy improvement with calibration option
- **Support flexible implementation with optimized power modes**
  - Configurable for Standalone Mode vs. MCU Mode
  - **SLEEP** and **DEEPSLEEP** low power options
- **Improve system robustness**
  - CB timeout, reset/shutdown input, random cell connection



# BQ77216

## Ultra-low-power voltage and temperature protector for 3S-16S

### Features

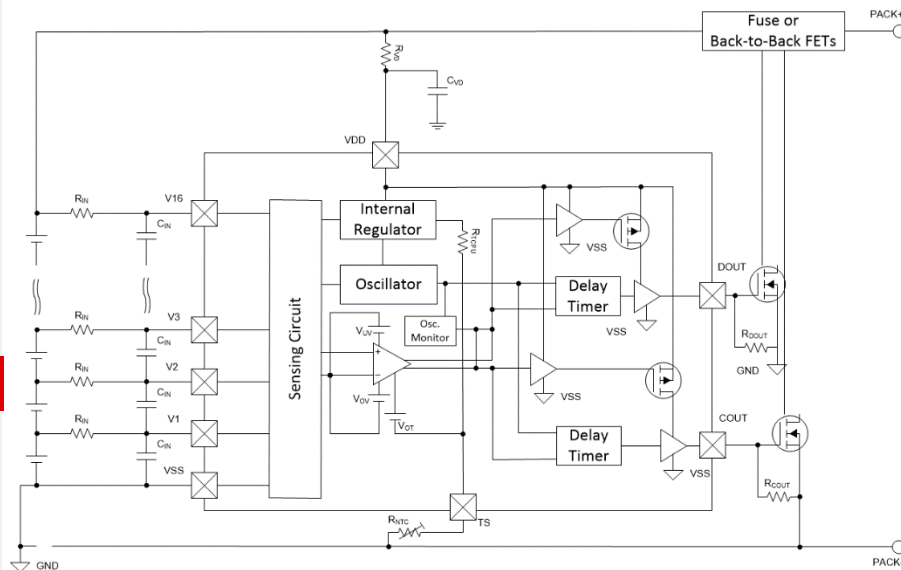
- **3S to 16S** Over-voltage (OV), Under-voltage (UV), Over-temperature (OT) and Open-wire (OW) protection device
- Output drive for **Fuse Blow** or **Back-to-Back FETs** active high or low
  - Active high drive to 6V or VDD, or Active Low Rail-to-Rail
- **High-Accuracy** of  $\pm 10$  mV @ 25°C
- **Low power** consumption (1  $\mu$ A typical, 2  $\mu$ A max)
- **Low Leakage** current per cell input < 100 nA
- **85V Battery Voltage withstand** capability for each cell pin
- Internal oscillator health check
- **Random cell connection** during production
- **Open-wire (OW)** detection option
  - $V_{Cn} < V_{Cn-1} - 0.2V$  Fault Detection
  - $V_{Cn} > V_{Cn-1} - 0.1V$  Fault Recovery
- TI-programmed (OTP) Configurations – contact TI for specifics
- 24L TSSOP with 0.65mm pitch

### Applications

- Power tools and garden tools
- Handheld vacuum cleaner
- Robotic Lawnmower
- eBike and eScooter
- UPS and Energy Storage

### Benefits

- **Cost-effective** for adding accurate voltage and temperature protection for a wide range of cell configurations
- **Reduced customer development and production time** due to TI programmed EEPROM



# More resources

- [Battery Management Deep Dive](#) technical trainings
  - Next BMS Deep Dive on October 12-13, 2021
- TI.com
  - [Wide portfolio](#) of chargers, gauges, monitors & protection ICs for any battery-related application, from 1S to xxxS
  - [BQ76952](#) product page with application notes, training videos, reference designs
  - [BQ77216](#) product page
  - [TI E2E™](#) design support forums

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