

# Battery Management Deep Dive Technical Training



## General topic

Presenter	Topic	Abstract
Jinrong Qian	<b>Kickoff and welcome: BMS update</b>	
Robert Spotnitz (Battery Design LLC)	<b>Invited keynote speech: modeling lithium-ion batteries</b>	The use of lithium-ion batteries in electric vehicles has driven an enormous maturation in modeling of lithium-ion batteries. This maturation is demonstrated by the range of commercial products now available for simulation of batteries. Simple circuit models gained prominence because they provide reasonable fidelity to experiments, are easy to parameterize, and numerically stable. On the other hand, physics models have realized dramatic developments in order to better understand the problems of aging and abuse, optimize battery designs, as well as simply to obtain high-fidelity electrothermal simulations. In particular, the unification of mechanical and electrothermal models promises to provide the capability to develop safe, long-lived batteries.
Yevgen Barsukov	<b>Special considerations in battery management for industrial applications</b>	Several functions of battery gauging, protection and smart charging are vital to the effectiveness of industrial applications. State of health is particularly important, because efficient use of the device in an industrial environment requires timely replacement before the device fails and disrupts manufacturing. Since most devices use DC/DC converters to maintain constant voltage at the device input, they effectively operate in constant power mode rather than constant current mode. This makes it critical to provide battery remaining energy (Wh) to estimate SOC, run-time and state of health in low temperature operations where energy loss of the battery is significant. High longevity is also important for many industrial applications, because it translates to lower cost of ownership. MaxLife technology extends predictable linear degradation rates and useable functionality of devices past 80% of traditional capacity loss, preventing exponential degradation that usually happens soon after this point. This presentation will review special considerations in battery management and will introduce new TI gauge and protector devices that support up to seven serial cells and are specially suitable for high-power industrial applications.
Ivo Marocco	<b>Automotive leadership</b>	TBD

## Gauge abstracts

Topic	Abstract
<b>Battery gauging fundamentals: how to overcome modern challenges for high-performance</b>	Innovations in portable electronics impose new challenges for battery fuel gauges. This presentation will look at the fundamentals of battery characteristics and how different gauging algorithms can be used to meet ever-changing requirements for high performance in various applications.
<b>Battery backup applications: CEDV vs. IT</b>	CEDV and Impedance Track™ technology offer two algorithms that can estimate the battery capacity of rarely discharged applications. This presentation will examine CEDV and Impedance Track options in gauging for backup applications and the parameters of each for superior performance.
<b>How to tune gas gauges for pulsed loads</b>	As battery power expands to emerging markets, so does the need for diverse load profiles. This presentation will detail gauge configuration and key considerations for applications with load profiles that include high amplitude and short duration pulses, with a focus on the latest Impedance Track™ single-cell gauge and how to ensure accurate performance.
<b>Optimizing single-cell, smart batteries to extend runtime and enhance system safety</b>	A wide variety of non-consumer applications need more than four-series cells but require small and compact design. This presentation will discuss methods to optimize total power consumption, extend system runtime and enhance overall safety for systems using a single-cell, smart battery pack with a highly integrated fuel gauge and protection controller. We will also look at several related TI products, including the BQ40Z80 and BQ27Z746.

## Guage abstracts (cont.)

Topic	Abstract
<b>When and how to simplify multicell gauge configurations</b>	The BQ40Z80 supports applications for five- to seven-series cell configurations and includes additional analog-to-digital converter and general-purpose input/output options. This presentation will discuss application-specific features for 5s, 6s and 7s configurations, their respective setups, and will highlight a TI device for each series-cell configuration.
<b>In the field: how accurate battery gauges are changing medicine as we know it</b>	Glucose monitoring is one of the fastest-growing segments in the medical industry. These systems increasingly rely on rechargeable batteries that require accurate fuel gauging to ensure reliable glucose-level measurements. This session will look at several glucose monitoring technologies and will examine how TI gauges support safer systems by helping to prevent potential medical emergencies.
<b>How to maintain high accuracy in applications without long rest periods</b>	This presentation will discuss how to support Qmax in applications without long rest periods, or applications whose battery packs are always under a load condition to allow qmx updates. We will also examine alternative algorithms that do not require long rest periods for an open circuit voltage measurement.
<b>Gauge roadmap: update and overview of next-generation products</b>	
<b>Winter is coming: how to tune your gauge for the best low-temperature performance</b>	One of the toughest conditions for battery-powered applications is low temperature. This presentation will cover the effects of low temperature on battery parameters and how to configure battery gauges to get superior accuracy at low temperatures while minimizing any impact on high-temperature performance.
<b>Troubleshooting common multicell gauge issues</b>	This presentation will cover the most common issues when setting up and using multicell fuel gauges. We will specifically look at the BQ40Z50, reviewing basic steps for troubleshooting each type of issue.
<b>Using gauge simulation to reduce design cycle time</b>	This presentation will examine challenges to accurate gauging, such as long cycle times for real-time gauging, and the configuration of gauging algorithms for cell and system load characteristics. We will look at gauge simulation as a solution for accelerated configuration and verification of the gauge, and how this can save time and cost.
<b>An introduction to the gauging algorithm for dynamic loads</b>	This presentation will review the basics of battery fuel gauging, including various gauging algorithms and when to use them. We will also address the configuration methodology as a best practice to ensure top gauge performance.

## Charger abstracts

Topic	Abstract
<b>The future of high-power-density battery charging</b>	Battery-powered system designers have the task of increasing power density and enhancing the user experience with faster and cooler charging. The latest innovations in power adapter capabilities have inspired new topologies for fast charging with ultra-high efficiency in mobile devices, from typical buck converters to more exciting inductor-based and inductorless options. This presentation will highlight the latest battery-charging power architectures for high-efficiency charging, including three-level buck converters and switched capacitors.
<b>Charger fundamentals: how to choose the right battery charger for your project</b>	This presentation will take an in-depth look at battery-charger features such as USB detection, power path and dynamic power management, and the various system requirements they support for a superior customer experience. We will also review TI's portfolio of battery chargers for a wide range of applications and how to choose the best battery charger solution for your project.
<b>How to use a smart charger for system control, monitoring and protection</b>	This presentation will outline several techniques to pair a charger with a power-path-integrated analog-to-digital converter to achieve battery status information that aids in monitoring and controlling charging conditions to protect a battery in harmful conditions and extend its life. We will examine several system power control and smart reset techniques, along with key system design considerations.
<b>The benefits of USB charging solutions for two-cell battery applications</b>	As demand for high-performance electronics rises, so does the need for increased system power. This presentation will introduce TI's new family of boost charger solutions and their charging and protection features. We will also review why a two-cell battery configuration is best for devices that require easy access to a 5-V USB adapter, due to its versatility and cost-saving benefits.
<b>How to design small and portable applications leveraging USB Type-C™ technology</b>	USB Type-C technology offers many benefits, including a smaller and more slender size, reversible orientation, faster charge times and universal charging capabilities. This session will look at how to design small and portable devices with USB Type-C technology using TI's portfolio of buck-boost chargers, which offer single-charger flash charging, dual USB Type-C input charging and dual battery pack charging options.
<b>How to choose the best companion parts for battery chargers</b>	Speeding time to market while improving features and functionality is a constant challenge. Any feature added in a product has its own power requirements, thereby demanding multiple voltage converters. This presentation will explore the basic building blocks for battery charger integrated circuits (ICs), companion parts for battery-charger ICs and when to use them. We will also review specific TI reference designs that showcase ICs in a pre-made, built and tested printed circuit board, in addition to considerations for choosing DC/DC converters and low-dropout regulators.

## Charger abstracts (cont.)

Topic	Abstract
<b>Chargers roadmap: update and overview of next-generation products</b>	
<b>Avoiding common mistakes in schematic design and PCB layout for battery-charging applications</b>	This presentation will look at how to prevent common challenges in battery charging to design applications with minimal electromagnetic interference, high efficiency, short charge time and accurate current sensing. To illustrate best practices, we will examine real-life issues found in schematic designs and printed circuit board (PCB) layouts that hinder performance and how to overcome them.
<b>How to design tiny, safe, and long-lasting battery products with switching chargers</b>	This presentation will outline different charger options for full-capacity charging in small-size batteries without compromising battery safety. Specifically, we will address how TI's portfolio of high-performance switching chargers support full-capacity charging for small-size batteries in a fast, cool and safe manner.
<b>Understanding battery charger low quiescent modes and how to use them</b>	This presentation will outline different charger options for reduced energy consumption without sacrificing battery performance. Specifically, we will address how TI's portfolio of chargers support various low-power modes, the differences between them and specific applications for each configuration.
<b>How to overcome design challenges for lithium-ion chargers to charge alternative battery chemistries</b>	With the ubiquitous use of batteries across consumer electronics, medical, industrial and automotive applications, new design challenges have emerged as engineers seek to handle wider temperature ranges, increase power and improve battery reliability. This presentation will explore alternative battery chemistries and new ways to use TI's lithium-ion chargers to meet the ever-changing demands of battery-powered technologies.
<b>How to avoid common design challenges in linear battery chargers</b>	Linear battery chargers provide a small, simple solution for many portable applications. Yet due to thermal management, input power limitations, output load behavior and other factors, a simple solution can quickly become complex. This presentation will address the most common pitfalls related to linear battery-charger designs and how to avoid them. We will explore specific troubleshooting techniques using real-life design examples that illuminate issues related to layouts and schematics for both power-path and non-power-path solutions.

## Battery monitoring and protection abstracts

Topic	Abstract
<b>Monitoring and protection roadmap: TI's next-generation products</b>	
<b>Design considerations for high-cell-count applications: industrial</b>	When designing for high-cell-count applications, determining the architecture can be time-consuming. This presentation will examine considerations for choosing protection, gauging, temperature sensing, current sensing, and charge and discharge field-effect transistor controls for industrial applications, in addition to the best TI device for each scenario.
<b>Design considerations for high-cell-count applications: automotive</b>	Stacking monitors and balancers in automotive battery packs requires a specific bill-of-materials component selection and printed circuit board layout. This presentation will dig deeper into the application circuits needed to ensure proper functionality and performance while surviving hot-plug events and noisy environments.
<b>How to optimize industrial battery pack design with next-gen battery monitors</b>	In this session, we will discuss how to optimize battery pack design and reduce overall system cost by leveraging TI's next-generation family of highly integrated battery monitors for packs ranging from 3s to 16s. We will also focus on system design and configuration best practices that utilize integrated subsystems.
<b>Improving measurement performance in battery management subsystems for industrial applications</b>	When designing a battery pack, ensuring accurate and efficient measurement within the system is critical. This presentation will examine the measurement subsystem in TI's newest monitors and describe how it can be optimized for resolution, measurement speed and system power dissipation.
<b>How to improve cell balancing for industrial and automotive applications</b>	Effective cell balancing can improve the usable capacity, lifetime and safety of a battery. In this presentation, we will review cell-balancing types and when to use them in various industrial and automotive battery-pack designs.
<b>How to optimize protection subsystems for industrial applications</b>	In this session, we will introduce the multiple advanced protection mechanisms of TI's next-generation family of battery monitors, including primary, secondary, manual and autonomous, as well as their internal diagnostic features.

## Battery monitoring and protection abstracts (cont.)

Topic	Abstract
<b>Improving measurement performance and integrity in noisy environments, like automotive battery systems</b>	In an automotive battery pack design, it is important to filter system noise to provide true accurate voltage measurement in a timely manner to ensure system safety. This presentation will examine how the automotive monitor measurement subsystems can provide fast, accurate, filtered data to the host.
<b>Functional safety mechanisms in next-gen automotive battery monitoring and balancing</b>	This presentation will cover the main safety mechanisms in the BQ7961X family of devices and will review their purposes and how to interpret them when triggered.
<b>How to ensure communication robustness with a daisy-chain architecture</b>	Communication robustness amongst monitors and balancers stacked in a daisy-chain configuration in automotive battery packs is paramount to the safety of the driver and the vehicle. This presentation will review the noise challenges of automotive applications and features of the BQ79606A-Q1 to ensure robustness.
<b>Automotive functional safety: what's new in ISO-26262 and Part 11 for semiconductors</b>	This presentation will review changes for the second edition of ISO-26262 with a focus on Part 11 and what they mean for the semiconductor industry.
<b>How to interpret built-in safety mechanisms for TI's latest monitoring and balancing products</b>	This presentation will cover the main safety mechanisms built-in to the BQ79606A-Q1 and will review their purposes and how to interpret them when triggered.

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