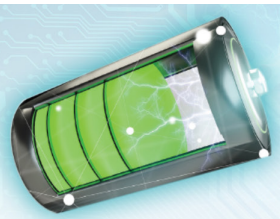

Battery Management
Deep Dive Technical Training

Texas Instruments

Session Descriptions - Day 1

Topic	Abstract
Introduction to Battery Fuel Gauging	Fundamentals of battery fuel gauging techniques and different algorithm approaches will be covered during this training. We will build up to and discuss the Compensated End of Discharge Voltage (CEDV) and Impedance Track (IT) algorithms and how to choose the best option for your applications. We will review the advantages and limitations of each of these gauging solutions.
Impedance Track and CEDV algorithms	
Understanding battery charger requirements and IC specifications (part 1)	This two-part session will start with an introduction to the basic requirements for a Li-Ion battery charging system. We will then review some of the system design choices like external power sources, input current and voltage monitoring, power path, converter topologies and efficiency, and explain how to compare different charging IC devices based on data sheet parametric specifications.
Understanding battery charger requirements and IC specifications (part 2)	
Basics of battery protection and safety	The use of batteries is simple, but protecting them is not always as straight-forward as one might imagine. This discussion will cover the basics of battery protection, from keeping them from over-charging and over-heating to what needs to be done at the system to implement battery authentication.

Session Descriptions - Day 2

Track	Topic	Abstract
GAUGE	**Keynote speech by Exponent** **An Inside Look at Lithium-Ion Cell Materials, Design, Assembly and Function**	For most users of lithium-ion cell technology, the environment inside the cell can or pouch is a “black box” that is most often treated as an electrical circuit element responsible for providing power to a device. In fact, the inside of a lithium-ion cell is a complex system that relies on chemistry, metallurgy, polymer science and mechanical engineering to bring together the components of a small chemical reactor. In this presentation we will explore the assembly of a lithium-ion cell, beginning at the molecular level, with the intent of providing a fundamental understanding of how the parts become the whole and define the operational characteristics of the cell. Examples of ‘what can go wrong’ in this complex system will be presented, from Exponent’s experiences in battery failure analysis.
GAUGE	**Battery fuel gauging for fast charging applications**	Find out how a gauge can facilitate fast charging in a single-cell system.
GAUGE	**Why accurate battery Gauging is needed for Wearables**	There are a number of challenges in wearable products that can be addressed by accurate fuel gauging. We will look at what makes this application unique and the benefits a gauge can bring to it.
GAUGE	**Multi-cell Gauging for industrial applications (bq40z50-R2)**	Though most famous for its wide use in notebook PCs, bq40z50 is also used in an array of other equipment. We will look at the different considerations for using it in industrial applications that are quite different from the notebook world and share lessons we have learned over the years.
GAUGE	**Battery Gauge System Design Overview - Process flow, tools, and configuration**	With this overview from start to finish of designing with and configuring a fuel gauge, you'll be in production in no time.
CHARGER	**Chargers for wearable, IoT, and small battery applications**	The availability of power is vital for small battery applications to produce robust reliable devices. Small batteries ranging from 25mAh to 450mAh that are expected to support continuously running systems need to maximize a minimal amount of energy storage. Chargers specifically designed to power and maintain these systems have specific attributes to produce a good user experience with a small amount of battery capacity. This session will explain the importance of parameters such as battery voltage regulation and termination current accuracy, battery leakage, and quiescent current; showing the delta of performance from solutions who concentrate on these parameters to those who do not.
CHARGER	**Chargers for Industrial and Medical Applications**	More and more portable devices are used in industrial and medical applications. For each of these two segments, or even different applications in the same segment, the charging requirements can be very different. What are the different system design challenges? How to pick the right chargers to fit the systems? How to solve the common problems in these applications? This presentation is going to answer these questions.
CHARGER	**How to implement maximum Power Point Tracking for Solar Charging applications**	A solar panel combined with the appropriately sized battery can provide continuous power for remote IOT and smart-home applications. For best performance, a solar battery charger should implement some sort of Maximum Power Point Tracking method to extract the most energy from a solar panel without overloading it. This presentation will explain the dynamic power management (DPM) and input current optimization (ICO) functions as well as illustrate the use of the internal A/D converter in advanced chargers for off-grid solar power applications.

Session Descriptions - Day 2 (cont.)

CHARGER	**Increasing maximum achievable current with High Efficiency Switch Mode charging solutions**	Efficiency has always been a key performance metric of switch-mode chargers. This presentation will show you how to characterize efficiency of a charger, as well as illustrate the key sources of loss and heat in the circuit and system. We will demonstrate how even a 1% improvement in efficiency can allow significantly higher charging current in a typical handheld device.
MnP	**Does cell balancing really help to extend battery life?**	Some customers see cell balancing as a must-have feature to extend runtime and battery life. Some believe cell balancing is not necessary if high quality cells are used. Some even find having cell balancing degrade their battery pack performance. We will discuss what are the cell imbalance factors and which factor can actually be balanced. We will review different balancing methods and their pros and cons.
MnP	**What are all these Safety Goals?**	When developing a Functional Safety system it is a requirement of ISO 26262 that safety goals be developed. Typically these safety goals are derived from the top level application, i.e. the car, and driven down to all subsystems. For Safety Elements Out of Context, such as Texas Instruments' bq76PL455A-Q1, the safety goals must be assumed. We will discuss why the safety goals were selected and how we assume they are used in a BMS system.
SYSTEM	**BMS solution for industrial battery packs**	This presentation will walk thru all possible combination of BMS ICs within a battery pack with >4s depending on the end-product.

Session Descriptions - Day 3

Track	Topic	Abstract
GAUGE	**Leveraging fuel gauging for intelligent power management**	A fuel gauge gives you a lot more information and features than just reporting state of charge. This presentation will point out other ways your system can utilize information from the fuel gauge to improve performance and user experience.
SYSTEM	**BMS for TELEMATICS/eCall**	This session will cover battery charger, gauge and protector choices for batteries used in eCall system, with Li-Ion/LiFePO4 chemistry
GAUGE	**Voltage Based Gauging**	In this talk we will go over the basic battery model and revisit some of the concepts used for simple voltage gauging. We then take a look into a more advanced approach to voltage based gauging and go over the high level concept of the voltage only approach. We will study the voltage based gauge and it's benefits to low power applications and discuss some differences to coulomb counting approaches. We finish by looking at the voltage based gauge in the Texas Instruments product portfolio.
GAUGE	**Gauge Roadmap: Update & overview of new generation products**	An overview of the gauge portfolio and how TI continues to innovate in hardware, algorithms, and features.
GAUGE	**Troubleshooting your gauge design**	We'll show some examples of the best approaches for debugging HW and gauge configuration issues.
GAUGE	**New Unique Gauging Algorithms for Industrial Applications (primary / EOS)**	If your application doesn't fit the typical charge/discharge use-case, you might need one of our recent unique algorithms to get you the information you need. From primary cells that need to last 20 years to backup batteries that rarely get used, how can you know when they no longer serve their purpose?
GAUGE	**Step-by-Step Design Example: 1s (Hands on Sessions)**	A hands-on walkthrough of designing with and configuring some of the most popular single-cell fuel gauges.
GAUGE	**Step-by-Step Design Example: bq40z50-R2 (Hands on Sessions)**	A hands-on session on using the most wide-spread multi-cell fuel gauge.
CHARGER	**To Comply with USB Power Delivery 3.0 Specification: Advanced applications of bq2570xA Buck-Boost Charger**	The USB type-C port becomes more popular in the past few years, which consolidates various data communication and the power transfer. The USB power delivery even extends the power capability up to 100W. This presentation introduces several advanced applications of bq2570XA buck-boost charger on the type-C PD products, such as power bank, car charger, type-C port on notebook, desktop, monitor. The typical 5V, 9V, 15V and 20V input voltages charge 1s~4s battery, therefore the buck-boost topology is required. The application diagram illustrates how the system is designed to comply the USB PD 3.0 specification. The competitive analysis identifies the unique features and advantages of TI's buck-boost charger over the competitors. Then how those TI unique features facilitate users to meet USB PD 3.0 specification will be explained. The features and benefits of TI's next generation buck-boost charger will be present in the last section.
CHARGER	**Introduction to USB Type-C and Power Delivery: Focus on charging applications**	USB Type-C and Power Delivery represent a big jump in the power available over USB and changing the types of products that can use USB as their power source. This talk will describe the technical aspects of these new USB standards and how different product types are affected. Then we will describe in detail USB Type-C charger (Source) application system design examples.
CHARGER	**Chargers Roadmap: Update & overview of new generation products**	

Session Descriptions - Day 3 (cont.)

CHARGER	**Easy-to-use charging options for low & medium power applications**	Sometimes, choosing the ideal device with the right combination of features can seem complicated. TI has recently introduced a new family of charging devices that support up to 3A charge current, and incorporate the most popular features like automatic USB source detection, external overvoltage protection, and high efficiency into one device. The bq2560x offers versions with either I2C programmability or simple resistor-programmed configuration. This presentation will show how you can get your battery management system up and running quickly with a minimum of time and effort.
CHARGER	**Reduce charge time with Advanced Narrow Voltage DC Charger implementation**	The "NVDC" or Narrow Voltage DC charging architecture has been utilized in switch-mode charger solutions for several years. The newest versions of these devices incorporate additional features like integrated A/D converter, adaptive VINDPM, and two-way communication with the external adapter. This presentation will explain how these new features can be used to optimize system-level efficiency and minimize charge time for high capacity batteries while keeping your product cool.
CHARGER	**Emerging Inductorless Topologies and System Architecture for > 5A Charging**	The traditional approach to high-current charging has usually involved the use of an inductor-based switch mode converter. But even high efficiency converters have their limitations, and the thermal challenges associated with high-density handheld devices have resulted in a practical limit for fast charging current with the conventional switch mode topologies. This presentation will explain some new architectures that employ other techniques to reduce heat in the portable device and enable very high current charging for high capacity Li-Ion cells.
CHARGER	**Practical guidelines for testing and troubleshooting your charger design**	PCB layout, current sensing, efficiency measurement, and I2C control: All of these can present challenges for an engineer who may be new to power management and battery charging applications. This presentation will show some of the real-life issues that may arise in building a battery charger solution and how to solve them.
CHARGER	**Dual charger solution and NiMH charger solution update**	This section will cover dual charger application solution and NiMH charger solution. For dual charger solution section: Understand different dual charger solution requirements, such as input source difference, operation mode difference and battery/system configuration difference. This section will also cover analysis of the charge function to meet these requirements, and also give several multi-charger solutions as reference for these applications. For NiMH charger solution section: introduce typical NiMH battery charging profile and current TI solution. It will also summarize typical charging profile for eCall application using NiMH, LiFePO4¬, and Li-ion batteries with automotive qualified TI chargers.
MnP	**Setting up your Daisy Chain Communication for success?**	Automotive battery packs are typically made up of multiple modules, requiring multiple battery monitor ICs to measure the entire stack. Two common methods to communicate to all of these devices is to have a MCU for every device or use a daisy chain configuration. This topic will briefly introduce the tradeoffs and then cover the what is necessary to set up the bq76PL455A-Q1 for daisy chain configuration to be robust at start up and in the face of communication failures.
MnP	**Monitoring and Protector Roadmap: Update & overview of new generation products**	
SYSTEM	**Designing with multi-rail PMIC**	This will be an in-depth look into a multi-rail PMIC with battery charging capabilities. We will take you into the world of PMIC's (Power Management IC's) from simple two rail power management to multi-rail power management with internal battery chargers. PMIC's can be easy to design with, they can save board space and they can save you money on BOM cost.
MnP	**Accurate Measurement of Power Inductor Losses – by Wurth Elektronik**	This presentation will guide you through the critical parameters for inductor selection in a DC-DC converter and how they affect total inductor losses. We will demonstrate how to make inductor selection easy and reliable using the most accurate AC loss calculation tool in the market – REDEXPERT.
SYSTEM	**New power modules with new features for Industrial**	Many industrial customers use power modules to reduce size and simplify design (ease of use), while still meeting high efficiency targets. New power modules offer smaller size, higher efficiency, better thermal performance, and new features which are demanded by the industrial market. Features such as forced PWM mode and voltage select (VSEL) increase their usability in a variety of industrial applications. Their low quiescent current (IQ) supports portable applications as well. Comparisons of these power modules to their equivalent discrete solutions demonstrate the advantages of using power modules, while also considering the tradeoffs required.