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Achieving Compliance to Small Format Battery Pack Standards

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- What I'm covering
  - Small Format
  - Lithium Secondary (Li-ion, Li-Polymer)
  - Battery Packs
  - Standards: IEC 62133:2012, UN 38.3, UL 2054
- What I'm not covering
  - Large Format
  - Primary (Non-Rechargeable) or other Secondary Chemistries
  - Cells
  - Other Cell or Battery Standards
  - Anything Proprietary or Overly Specific

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- Test Standard Review
- Common Problems
- Risk Matrix 
- Mitigation Considerations

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IEC 62133 Overview

- **IEC 62133:2012 (2nd Edition) – Rechargeable cell/battery safety**
  - **Main standard for International compliance**
  - **1ST Edition still active until Dec 2015 (EN 62133)**
  - **Testing covered by UN 38.3 removed in 2012 edition**

IEC62133:2012
8.2.2 Moulded Case Stress
8.3.2 External Short Circuit
8.3.3 Free Fall
8.3.6 Overcharging of Battery

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IEC 62133 Test Protocol

- Moulded Case Stress
  - 70°C / 7 hours
  - Fully Charged
  - Criteria: No components exposed
- External Short Circuit
  - 55°C
  - 1 hour if circuit trips
  - Criteria: No fire / No Explosion
- Free Fall
  - No thermal pre-conditioning
  - 1 meter / 3X at room temp
  - Criteria: No fire / No Explosion
- Overcharging of Battery
  - Start discharged
  - 2C charge rate
  - Max voltage of charger or if not available, 5V/cell
  - Run until temp returns to ambient or stabilizes.
  - Criteria: No fire / No Explosion

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IEC 62133 Risk and Mitigation

- **IEC 62133 – Rechargeable cell/battery safety**
  - **Reasonable robustness to mechanical and electrical stress**

IEC62133:2012
8.2.2 Moulded Case Stress
8.3.2 External Short Circuit
8.3.3 Free Fall
8.3.6 Overcharging of Battery

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UN 38.3 Overview

- **UN 38.3 – Lithium transportation testing**
  - **Sequential testing (multiple tests/same samples)**
  - **Mechanically Intensive**

UN38.3
T1: Altitude
T2: Thermal
T3: Vibration
T4: Shock
T5: Short
T7: Overcharge

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UN 38.3 Test Protocol

- T1-T5 Sequential
  - T1 Altitude
    - 50,000 ft – 6 hours
  - T2 Thermal
    - +75/-40C – 130 hours
  - T3 Vibration
    - 7-200Hz up to 8G
    - 3 hours per plane x 3 planes
  - T4 Shock
    - 150G/6ms
    - 18 impacts
  - T5 Short Circuit
    - 55C

- Rechg Packs Only
  - T7 Overcharge
    - 1.2 – 2X Mfg Chg Voltage
    - 2X Max Chg Current
    - 24 hours

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UN 38.3 Risk and Mitigation

- **UN 38.3 – Lithium transportation testing**
  - **Focus on mechanical robustness (vibration/shock)**
    - ***Consider pre-testing for low margin designs***
  - **Ensure safety circuit has margin for overcharge**

UN38.3
T1: Altitude
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UL2054 Overview

- **UL 2054 – Household & commercial batteries**
  - Required by some US end-product standards
  - Two "levels" of testing
    - Rated operating current ("Recognized Component")
    - Worst-case operating current ("Listed Product")
  - Single faults

UL2054	
9 Short Circuit (RT)	13A Component Temp
9 Short Circuit (55C)	13B Surface Temp
10 Abnormal Charge	19 250N Steady Force
11 Abusive Overcharge	20 Mold Stress Relief
12 Forced-Discharge	21 Drop Impact
13 Limited Power Source	

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UL2054: FAULTS

- **Common faults used in battery testing**
  - **Short source to drain of charge or discharge FET**
  - **Tie charge or discharge FET gate to Cell + or Cell –**
  - **Short sense resistor**
  - **Short FET control outputs from the safety IC (charge and discharge) together**

  - **NOTE: If components are too small to fault or inaccessible, UL's acceptable practice is to fault out the entire board.**

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UL2054 Test Protocol (Electrical)

- Short Circuit (RT/55°C)
  - Faulted
  - Run just below trip point
- Abnormal Charge
  - Faulted
  - Run just below trip point
  - High current test
  - Runs to taper + 7 hours
- **Abusive Overcharge**
  - **Faulted**
  - **High voltage test (6V/cell)**
  - **Run till stable or event**
- Forced Discharge (Series)
  - Faulted
  - One cell string fully discharged
  - Hard short
- Limited Power Source
  - Faulted
  - Will device deliver >8 A or >100 VA after:
    - 5 sec (1 Safety)
    - 60 sec (PTC+Safety)
  - Barrier to “listed product”

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UL2054 Test Protocol (Mech/Thermal)

- Component/Surface Temp
  - Not faulted
  - Worst-case or rated operation
  - Are component thermal ratings exceeded at max thermal environment?
  - Does surface temp pose a handling hazard?
- 250N steady force
  - Push on sides of case
  - Need I say more…?
- Mold Stress Relief
  - Battery discharged
  - Temp dependent upon results of component temp test (inside of enclosure)
  - 7 hours
- Drop Impact
  - Battery fully charged
  - 3 hr pre-conditioning if low operating temp ≤ 0°C
  - 1 m / 3X
  - Criteria: No fire, explosion, or protective devices exposed.

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Risk and Mitigation

- **UL 2054 – Household & commercial batteries**
  - Understand what faults will be applied to your design
  - Understand what happens at each faulted worst-case current
  - Have two levels of safety in your device (we're faulting one of them)
  - Know if LPS compliance is important to you (and your customer)
  - Understand how hot your components get and add your max operating temperature (or better, experiment at that temp)
  - Check your plastic for molded-in stress and drop integrity when cold

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Summary

- What standards apply to my product
- Evaluate tests by risk
- Understand product behavior at test conditions
- Develop mitigation strategies for the design
- Consider pre-testing to reduce schedule risk
- Talk to your test provider early

IEC62133:2012	UN38.3	UL2054	
8.2.2 Moulded Case Stress	T1: Altitude	9 Short Circuit (RT)	13A Component Temp
8.3.2 External Short Circuit	T2: Thermal	9 Short Circuit (55C)	13B Surface Temp
8.3.3 Free Fall	T3: Vibration	10 Abnormal Charge	19 250N Steady Force
8.3.6 Overcharging of Battery	T4: Shock	11 Abusive Overcharge	20 Mold Stress Relief
	T5: Short	12 Forced-Discharge	21 Drop Impact
	T7: Overcharge	13 Limited Power Source	

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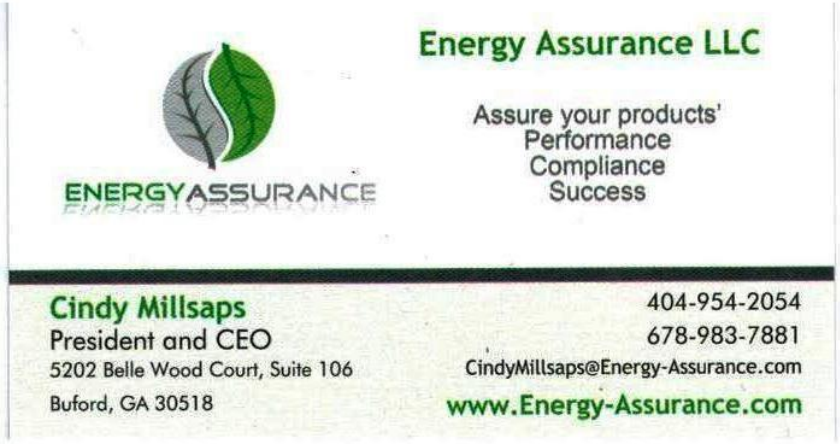
Contact Info



QUESTIONS…?