Critical Safety Elements in Smart Battery Pack Design

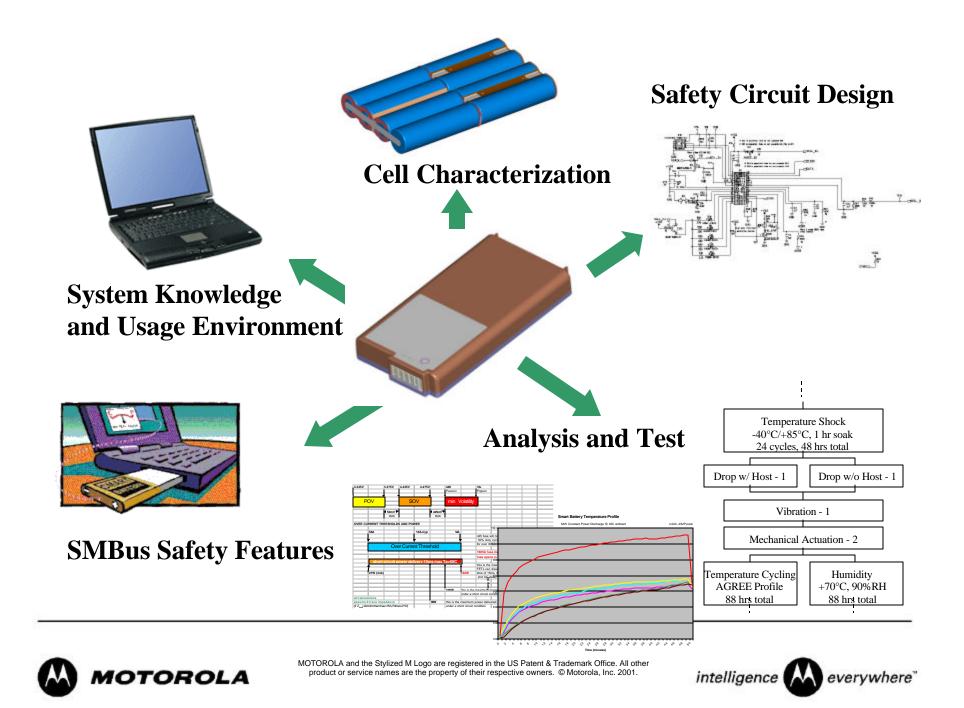
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Safety Test Requirements for Li Ion Cells

Cell Characterization

• Cell safety performance data should be thorough

• Optimum safety circuit design strongly depends on good cell characterization data

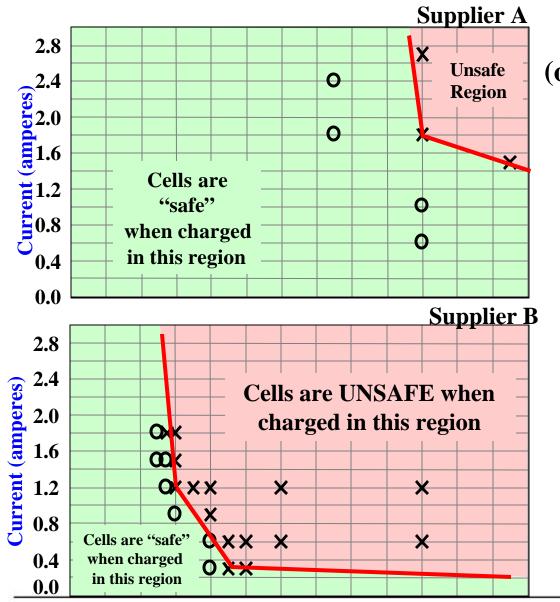
• Testing is crucial

Failure	Description	Purpose	Referenc			F	Requirement	S
Code				Leak	Vent			Other
fic safety	abuse tests.						•	
A	Thermal abuse, oven test at 150 C for 60 minutes	Ability to withstand thermal abuse and test relative cell stability. Minimum survivability is 10 minutes (UL spec).	modified UL			x	х	Cell surface T 200 C
A	Thermal abuse, oven test at 130 C for 60 minutes	Ability to withstand thermal abuse. Test performed only if cell fails #3 before 60 minutes.	IEC			х	х	Cell surface T 200 C
А	Crush, flat plates as per UL 2054	Ability to withstand mechanical abuse	UL and IEC			х	Х	
A	Impact, round bar and weight as per UL 2054	Ability to withstand mechanical abuse from sudden impact	UL and IEC			х	х	
В	Short circuit, < 0.5 ohm load, 60 C	Ability to withstand short circuit	UL and IEC			Х	Х	Cell surface T - 150 C
В	Short circuit, < 0.5 ohm load, room temp.	Ability to withstand short circuit	UL and IEC			х	Х	Cell surface T - 150 C
В	Overcharge at I _{0,} V= 5 V	Survive minimal level of overcharge	modified UL/IEC			x	X	
В	Overcharge at 3I _{0,} V= 4.5 V	Survive faulty charger condition	modified UL/IEC			х	Х	
В	Overcharge mapping: 3 cells at 5 different test currents; V= 10 V	Determine maximum safe level of overcharge for safe design						
В	Forced dise							0
	Code fic safety A A A A A B B B B B B B B C C C C C C C	Codefic safety abuse tests.AThermal abuse, oven test at 150 C for 60 minutesAThermal abuse, oven test at 130 C for 60 minutesACrush, flat plates as per UL 2054ACrush, flat plates as per UL 2054BShort circuit, < 0.5 ohm load, 60 CBShort circuit, < 0.5 ohm load, coom temp.BOvercharge at $I_{0,}$ V= $5 V$ BOvercharge at $3I_{0,}$ V=4.5 VBForcedarge mapping: 3 cells at 5 different test currents; V= 10 V	Codefic safety abuse tests.AThermal abuse, oven test at 150 C for 60 minutesAThermal abuse, oven test at 130 C for 60 minutesAThermal abuse, oven test at 130 C for 60 minutesACrush, flat plates as per UL 2054BShort circuit, < 0.5 ohm load, 60 CBOvercharge at 10, V = 4.5 VBOvercharge at 310, V = 4.5 VBOvercharge at 310, V = 4.5 VBOvercharge for solution overchargeBOvercharge for solution overchargeBOvercharge for solution overchargeCovercharge for solution overchargeCovercharge for solution overchargeCovercharge for solution overchargeCovercharge for solution overcharge for solutionCovercharge overcharge for solutionCovercharge for solutionCover	CodeImage: constraint of the second seco	CodeLeakfic safety abuse tests.Ability to withstand thermal abuse and test relative cell stability. 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Lithium Ion Cell Failure (overcharged, insulated cells)

• All cells are not created equally

• Failure to take into consideration the differences between cells could lead to a safety circuit that is either under-designed or over-designed

> O "Safe" ➤ Flame

4.0 4.2 4.4 4.6 4.8 5.0 5.2 5.4 5.6 5.8 6.0 6.2 6.4 6.6

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