

Battery Sensing Solutions with NGK for 1-Cell Rechargeable Li-ion/LiPo Battery

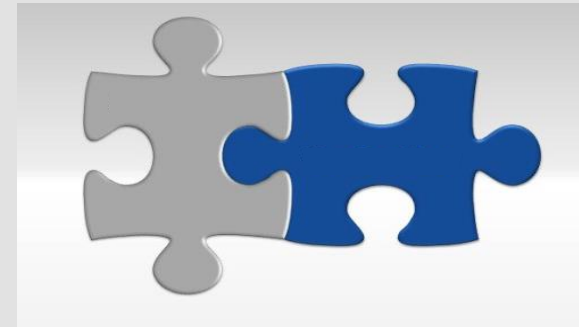
Oct. 2022

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“NGK & onsemi からのサポート”

事前に最適なパラメータ/データを提供する

- 1) 検証時間の削減
- 2) 入れ替えリスクの軽減



+

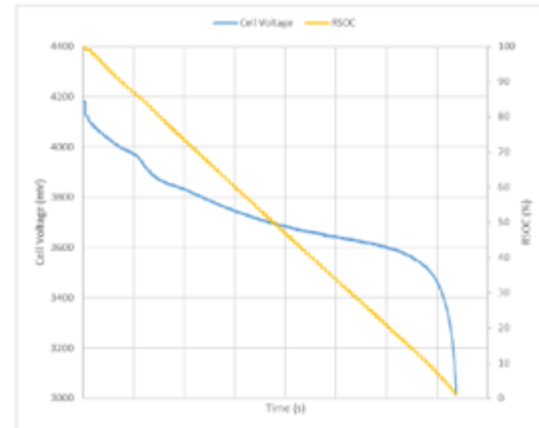


* EnerCera is a products of NGK Insulators, Ltd. *NGK EnerCera Lithium-ion battery image (used with permission from NGK Insulators, Ltd.)

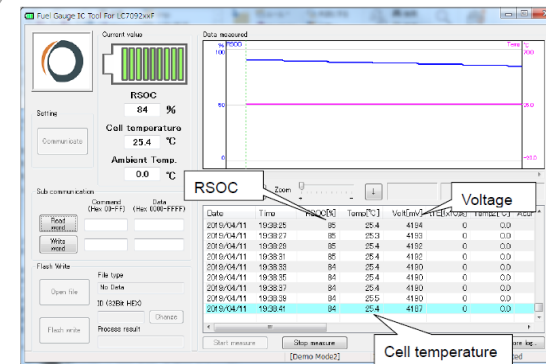
顧客へのサポート

- *NGKエナセラバッテリー & onsemi バッテリーセンシング (Fuel Gauge) ICとのマッチングデータを提供し、評価プロセスの短縮を実現
 - FGツールにより、低消費電力動作の検証を容易にできる
 - *NGKエナセラバッテリー & onsemi ソリューションがシステムの小型化に貢献
- * EnerCera, エナセラ は、日本ガイシ株式会社の製品です

Graph the .csv file.



This graph shows association between time and cell voltage and RSOC in constant current discharging.

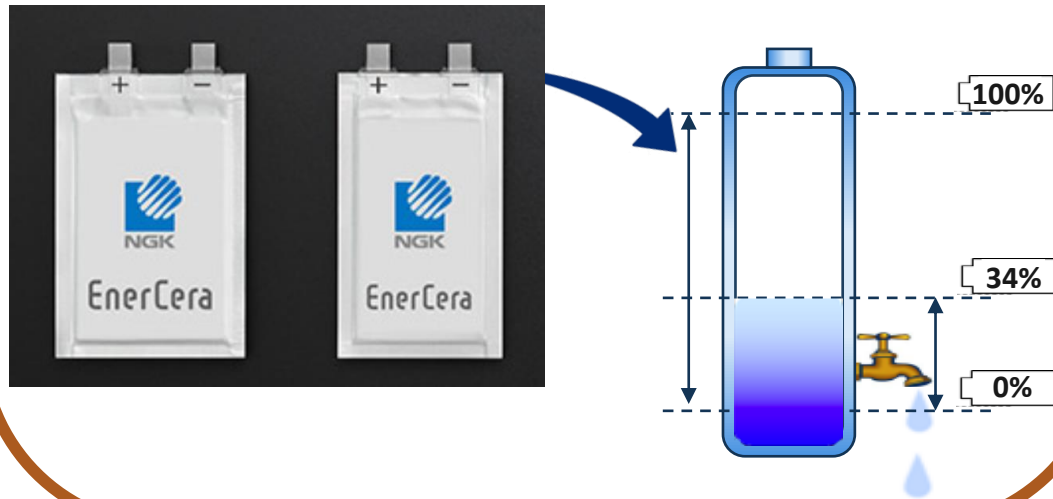


onsemiバッテリーセンシングソリューションの課題と意義

パワーシステムの要求事項

- 高い安全性
- 長時間稼働

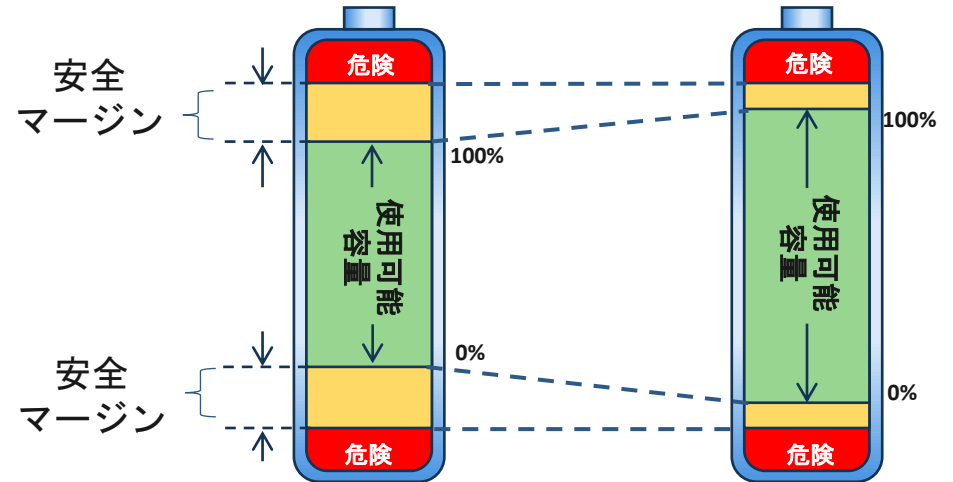
NGK EnerCeraリチウムイオン電池のイメージ図
(日本ガイシ株式会社の許諾を得て使用しています)



バッテリーセンシングの役割

- システムの**安全性**を保持
- **エネルギーの有効利用**を支援

onsemi
Battery
sensing



バッテリーセンシング機能

- RSOCのレポートに対応
- バッテリーの電圧、温度、劣化具合のレポートに対応

onsemi バッテリーセンシングソリューション主な特長



高精度

変化に対して安定した高精度な計測

電池組成の化学的物理学に裏付けられた電池プロファイルによる独自の測定方法により温度変化やバッテリー劣化に対しても高精度な残量計測を実現

低消費電力

業界最小の消費電力

デュアルクロックアーキテクチャにより極めて低い動作電力を実現

電流測定用 外付け抵抗不要

BoM数の削減

電流測定用外付け抵抗が不要なアルゴリズム採用。プリント基板への実装面積を小さくすることで、製品の設計自由度を高め、コストメリットに寄与

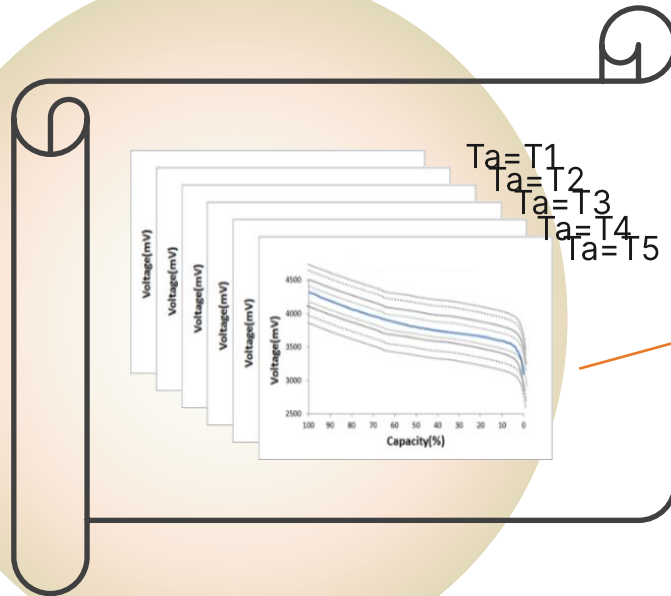
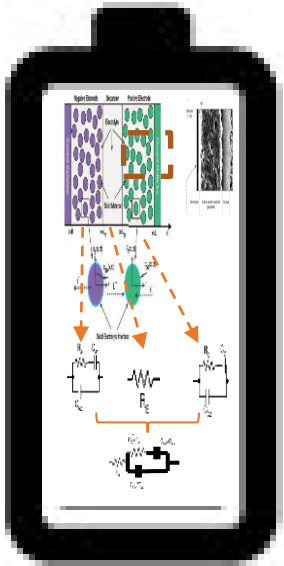
高精度な残量計測の実現

onsemi ソリューションの特長

- 実測値と電池の化学的性質に基づいたパラメータを持つ独自のルックアップテーブルを活用したバッテリープロファイリング
- さまざまな環境下でも安定した測定を実現するバッテリーの内部抵抗

onsemi のバッテリーセンシング技術は、下記の条件に関わらず安定した精度を実現

- バッテリーの劣化
- 温度変化
- 充放電の繰り返し



Fuel Gauge

感知条件

- 1) 温度
- 2) 電圧
- 3) 電流

計算

$$SOC(t) = SOC(t_0) - \frac{1}{Q_{rated}} \int_{t_0}^t \eta(t) I_{bat} dt$$

報告事項

- I2C communication
- Alert output

バッテリープロファイル (NV メモリー)

バッテリープロファイルテーブルに対応する複数のパラメータ
 - 充電電流, 放電電流
 - 温度、-OCVからの電圧変化

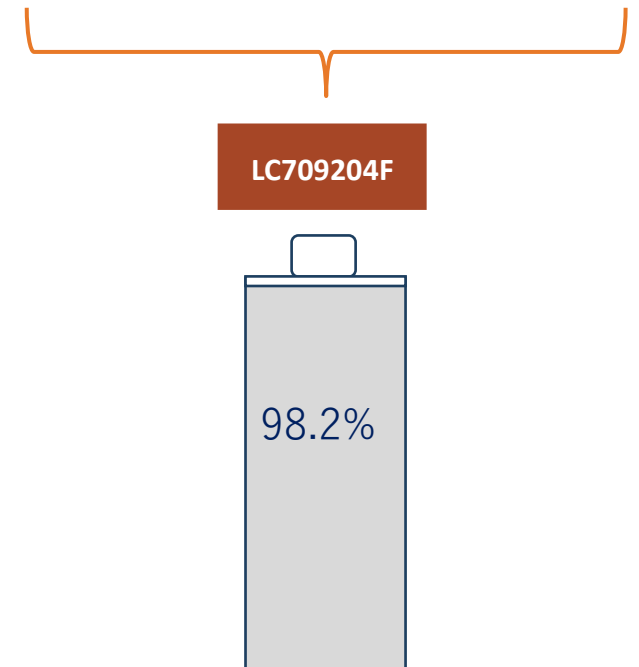
低消費電力

消費電力

LC709204F	
測定方法	onsemi 独自技術
消費電流 (稼働モード)	<u>2</u> μ A

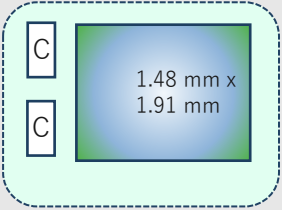
- LC709204Fの消費電流はわずか2 μ Aと圧倒的な低さを実現
- 動作時の消費電力が極めて低い

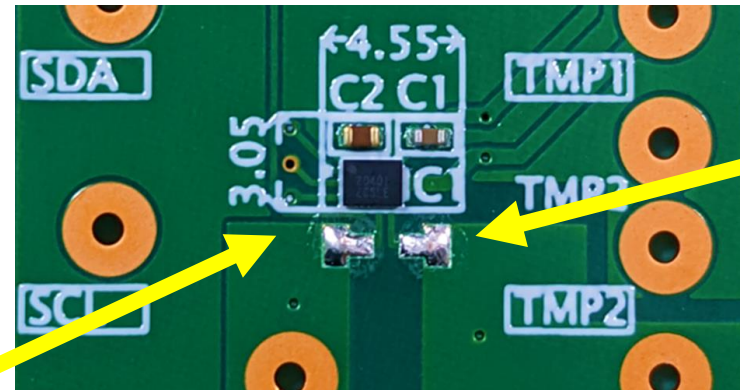
顧客製品を30日間倉庫に
保管した場合の電池残量
(計算値)



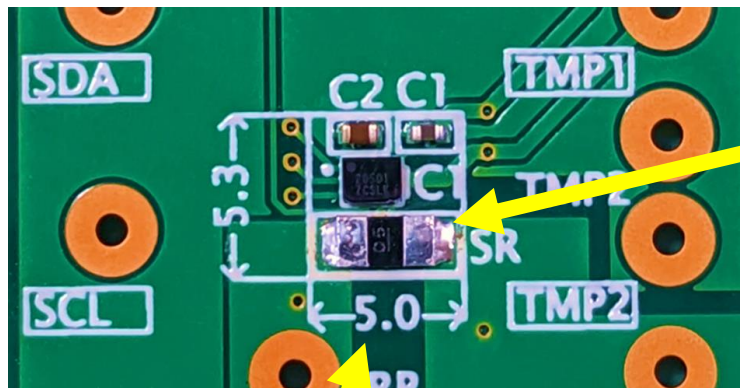
(80 mAh Battery)

電流測定用外付け抵抗不要

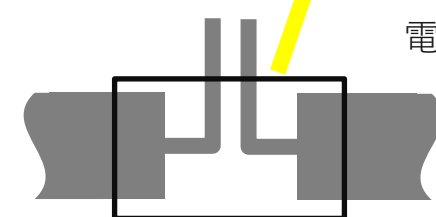
	onsemi LC709204F
電流測定用外付け抵抗	不要
外部部品数	電流測定用外付け抵抗: 0 抵抗器: 0 キャパシター: 2
フットプリントイメージ	



電流測定用
外付け抵抗なし



電流測定用
外付け抵抗あり



電流測定用外付け抵抗の代表例(5 mΩ, 1%) :

PCBフットプリント: 配線パターン

顧客メリット(小型化):

- ウェアラブルや小型のアプリケーションでは、電流測定用外付け抵抗がないことの重要性が高まっている
- 電流測定用外付け抵抗のためのフットプリントは、外付け抵抗パッケージ寸法より大きい

onsemi バッテリーセンシングベースモデル LC709204F

onsemi
LC709204
F

LC709204F

業界最小クラスの低消費電力とサイズを実現したベースモデルは、安全性と柔軟なサイズ設計のために充実した警告機能に対応

- 外部部品 : 2pcs
- 低消費電流 : 2uA

バッテリーモニターレポートの強化

IC	LC709204F
Advanced	Rescaled RSOC
	Time to Empty
	Time to Full
Alarm	Ambient Temperature
	High/Low Voltage
	Low RSOC
	High/Low Temperature
Battery Lifetime	Estimated SOH
	Cycle Count
	Max/Min Cell Voltage
	Max/Min Cell Temperature
	Total Runtime
	Accumulated Temperature
	Accumulated RSOC

Key Take Away

onsemi バッテリーセンシングソリューション

高精度なゲージング
変化に対して安定した高精度な計測

消費電力を極限まで抑え、バッテリー状況をモニタリングする

電流測定用外付けBoM抵抗なし、数の削減

Data Sheet
[Click Here](#)

Battery Fuel Gauge LSI [Smart LiB Gauge] for 1-Cell Lithium-ion/ Polymer (Li+) with Low Power 2 μ A Operation

ON Semiconductor
www.onsemi.com

LC709204F

Overview
 LC709204F is a Fuel Gauge for 1-Cell Lithium-ion/Polymer batteries. It is part of our Smart LiB Gauge family of Fuel Gauges which measure the battery RSOC (Relative State Of Charge) using its unique algorithm called HG-CVR2. The HG-CVR2 algorithm provides accurate RSOC information even under unstable conditions (e.g. changes of battery; temperature, loading, aging and self-discharge). An accurate RSOC contributes to the operating time of portable devices. The Fuel Gauge (in other words, Gas Gauge, Battery Monitor or Battery Gauge) feature of HG-CVR2 algorithm makes LSI highly applicable in various application. The LSI can immediately start battery measurement by setting a few parameters after battery insertion. Learning cycles that make complicated manufacturing process of applications can be avoided. The LSI also supports battery safety by alarm functions and SOH (State of Health) reporting to the application processor. The operating consumption current is very low 2 μ A and it is suitable for applications such as wearables and 1 series N parallel batteries.

Features

- HG-CVR2 Algorithm Technology
 - Small Footprint: No Need for Current Sensing Resistor
 - Accurate RSOC of Aging Battery
 - Stable Gauging by Automatic Convergence of Error
 - Immediate Accurate Gauging after Battery Insertion
 - Eliminates Learning Cycle
- Low Power Consumption
 - 2 μ A Operational Mode Current
- Improvement of the Battery Safety by Alarm Function
 - RSOC / Voltage / Temperature
- Battery Lifetime Measurement
 - SOH / Cycle Count / Operating Time
- Remaining Time Estimation
 - Time to Full / Time to Empty
- Three Temperature Inputs
 - Inputs to sense two NTC Thermistors
 - Via I²C
- Detection of Battery Operating Conditions
 - Charging / Discharging
- Detection of Battery Insertion
 - I²C Interface (supported up to 400 kHz)
- These Devices are Pb-Free, Halogen Free/BFR Free and are RoHS Compliant

Applications

- Wearables / IoT Devices
- Smartphones/PDA Devices
- Digital Cameras
- Portable Game Players
- USB-related Devices

MARKING DIAGRAM

204** = 20401 (LC709204FXE-01TBG)
 A = Assembly Site
 WL = Wafer Lot Number
 YW = Assembly Start Week

ORDERING INFORMATION
 See detailed ordering and shipping information on page 20 of this data sheet.

Applications

- Wearables / IoT Devices
- Smartphones/PDA Devices
- Digital Cameras
- Portable Game Players
- USB-related Devices

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 September, 2019 - Rev. 0
 Publication Order Number: LC709204F-D

App Note
[Click Here](#)

Battery Fuel Gauge [Smart LiB Gauge] for 1-Cell Lithium-ion/Polymer with LC709204F

ON Semiconductor
www.onsemi.com

AND9985/D

APPLICATION NOTE

LC709204F is a Fuel Gauge for 1-Cell Lithium-ion/Polymer batteries. It is a part of our Smart LiB Gauge family of Fuel Gauges which measure the battery RSOC (Relative State Of Charge) using its unique algorithm called HG-CVR2. The HG-CVR2 algorithm provides accurate RSOC information even under unstable conditions (e.g. changes of battery; temperature, loading, aging and self-discharge). This application note will explain how to initialize various parameters for the selected battery to start a higher accuracy gauging. Users can see various registers based on their application requirement using the notes, guidelines and examples given in this note. Sample program codes explained at the end of the note will provide various guidelines on how this device communicates with the host side application processors.

Figure 1. An Example of an Application Schematic Using LC709204F

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 April, 2021 - Rev. 1
 Publication Order Number: AND9985/D

Evaluation Board
[Click Here](#)



LC709204FXE-N01-GEVB

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Test Procedure for LC709204FXE-N01-GEVB

1 Evaluation Kit

1.1 How to select Evaluation board

Select a suitable Evaluation board according to target device and your battery.

Evaluation board	Target device	Battery Type	Related documents
LC709204FXE-N01-GEVB	LC709204FXE-01TBG	EC01	LC709204FXE-01-GEVB_SCHEMATIC.pdf
		EC02	LC709204FXE-01-GEVB_GERBER.zip
		EC03	LC709204FXE-01-GEVB_BOM.pdf
		EC04	

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Appendix

LC709204F Product Overview

Battery Fuel Gauge with Low-Power 2 μ A Operation

Unique Features	Benefits
HG-CVR2: Unique gauging methodology based on battery's chemical composition	Highly accurate and robust RSOC gauging
2 μ A ultra low operating current	Energy efficient
Battery lifetime report	Provides system safety
Multi NTC thermistor sensing inputs	Monitors system/battery temperature
One-chip sensing without sensing resistor	PCB footprint area

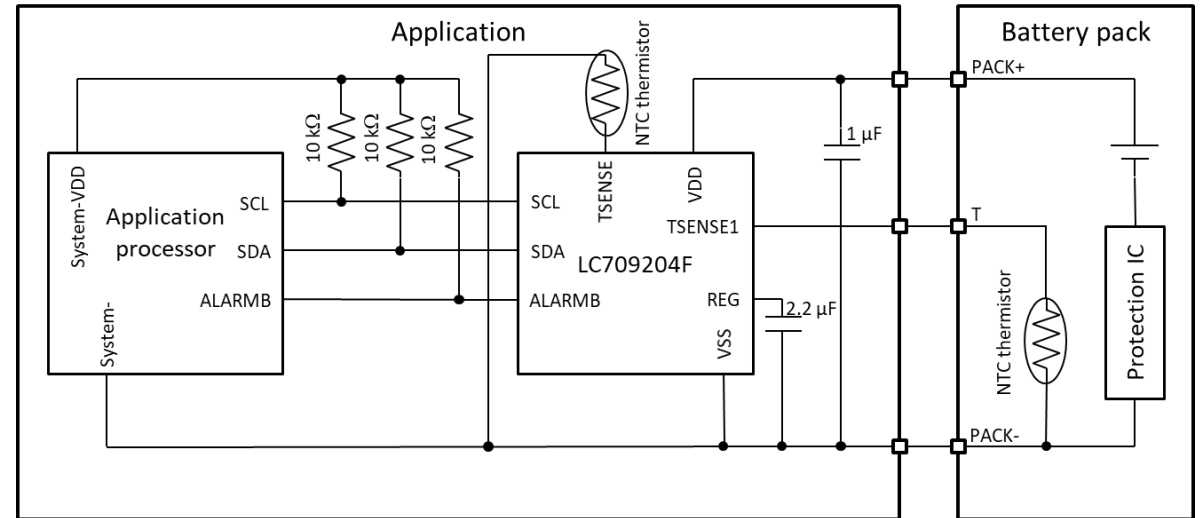
Other Features

- Target battery type: 1-Cell Lithium-ion/Polymer. Pouch and Prism, Cylinder type
- Battery capacity range: Up to 6,500 mAh x Parallel cell number
- Alarms for high and low voltage, current, temperature, RSOC to the host using dedicated output
- Auto empty adjustment to protect the system from voltage drop of aged battery
- The maximum and minimum condition records for failure analysis
- I²C Interface (supported up to 400 kHz)
- 32 bits non volatile memory to be usable for any usage

Markets & Applications

- Wearables
- Wireless headsets
- IoT devices
- Smartphones / PDA devices
- Portable game players
- USB-related devices

Typical Application Schematic



Ordering & Packaging Information

ONPN	Description	Package
LC709204FXE-01TBG	Battery Fuel Gauge LSI for 1-Cell Lithium-ion/Polymer (Li+) with Low-Power 2 μ A Operation	WLCSP12, 1.48x1.91x0.51



onsemi Fuel Gauge Product

Model	LC709204FXE
Algorithm	HG-CVR2 ^{*1}
Package	WLCSP12
Size	1.48 mm x 1.91 mm x 0.51 mm
Pin Pitch	0.4 mm
Max Voltage	5.0 V
Accuracy	±2.0%
Operating Idd	2.0 μA
Rescaling	√
Alarm	5
Sense Temperature	2xNTC Thermistor , Host Reported
Basic Report ^{*2}	√
Advanced Report ^{*3}	√
Battery Lifetime Report ^{*4}	√
Current Report ^{*5}	Option ^{*6}
User ID	√
Battery Embedded/Removal	√
Embedded Battery Profile	5

Notes:

- *1: HG-CVR2 - Increased look-up tables to increase the device gauging accuracy
- Improved sampling timing to reduce the overall power consumption
- *2: Basic Report - RSOC, Cell Voltage, Cell Temperature
- *3: Advanced Report - Rescaled RSOC, Time to Empty, Time to Full, Ambient Temperature
- *4: Battery Lifetime Report - Cycle Count, SOH(State of Health), Total Run Time
- *5: Current Report - Remaining Capacity, FCC, Average Current, Dynamic Current
- *6: Contact your onsemi FAE

Alarms and Battery Lifetime Reporting

- LC709204F sends an alert to a host via an alarm function with little or no delay, when battery operating conditions exceed the parameters set up by the customer
- A record of historical data and stresses applied to the battery are logged in the battery lifetime report

IC	LC709204F
Advanced Reports	<ul style="list-style-type: none"> • Rescaled RSOC • Time to Empty • Time to Full • Ambient Temperature • Battery Status
Alarm Conditions	<ul style="list-style-type: none"> • High/Low Voltage • Low RSOC • High/Low Temperature • Over-Charge/Discharge Current ^{*1}
Battery Lifetime Reports	<ul style="list-style-type: none"> • SOH • Cycle Count • Max/Min Cell Voltage • Max/Min Cell Temperature • Total Runtime • Accumulated Temperature • Accumulated RSOC • Ave/Dynamic Cell Current ^{*1} • Full Charge/Remaining Capacity ^{*1}

*1. Optional. Please contact your onsemi FAE for details.

Thank you
