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

Oct. 2022
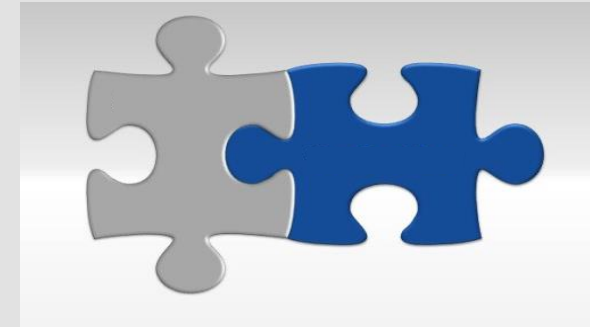
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Support from NGK INSULATORS & onsemi

"Solutions from NGK & onsemi"

Provide qualified parameter/data in advance

    1) Save time for qualifications

    2) Reduce risks for replacement

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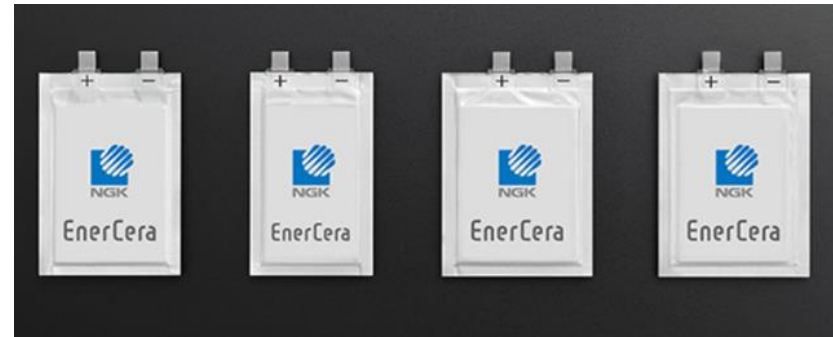
* EnerCera is a products of NGK Insulators, Ltd. *NGK EnerCera Lithium-ion battery image (used with permission from NGK Insulators, Ltd.)

Support from NGK INSULATORS & onsemi

Support for Customers

- Provide matching data with *NGK EnerCera battery & onsemi Fuel Gauge IC which reduces qualification process

- Tool can make it easier to qualify low power operation

- *NGK EnerCera & onsemi solutions contribute physically small size system

* EnerCera is a product of NGK Insulators, Ltd.

Graph the .csv file.
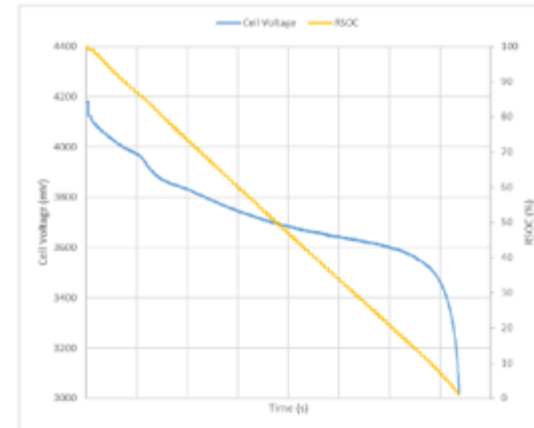
This graph shows association between time and cell voltage and RSOC in constant current discharging.

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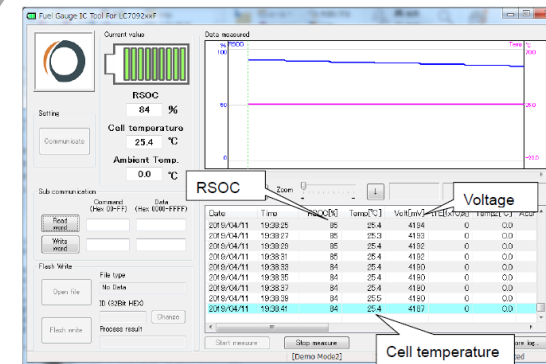
Requirements and Role of Battery sensing solutions

Requirements from power system
- **High safety**
- **Long operating time**

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

100%

34%

0%
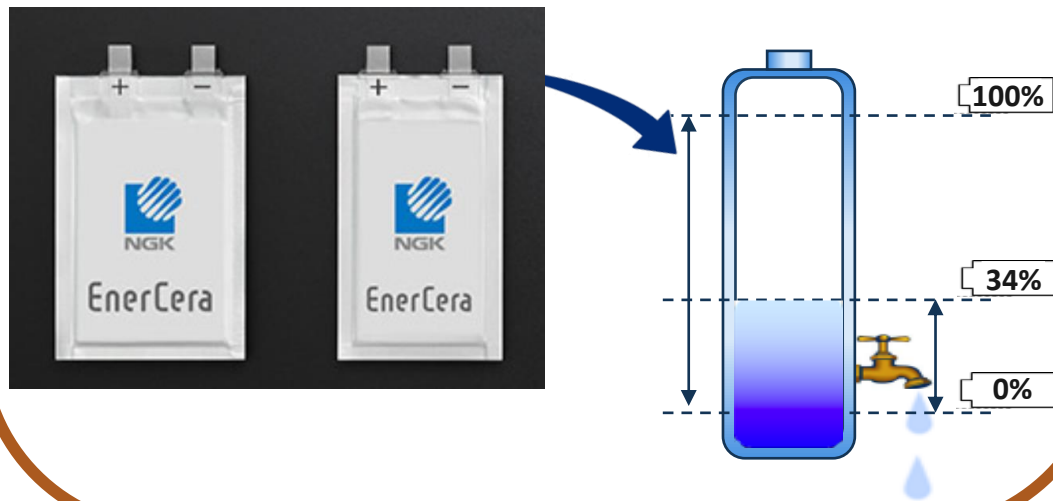
Role of the Battery sensing solution
- **Keep system safety**
- **Support efficient energy use**

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Battery sensing

Margin to hazardous zone

Danger

Operational Capacity

100%

0%

Danger

Margin to hazardous zone

Danger

Operational Capacity

100%

0%

Danger
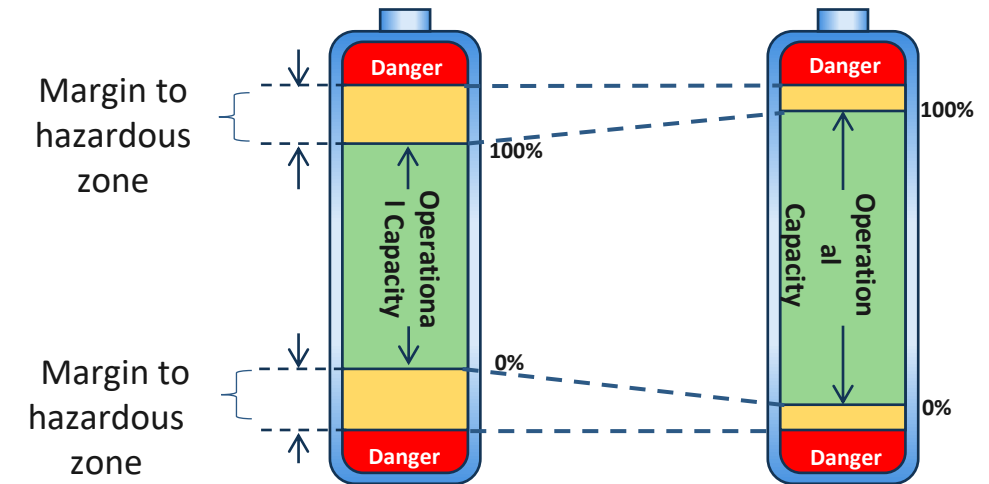
The function of Battery sensing
- Fuel gauge supports base report as RSOC
- Indicates status of battery voltage, temperature, and health

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onsemi Battery Sensing solution features

LC709204F
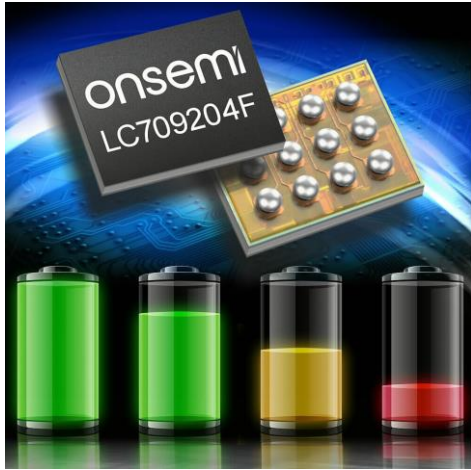
Accurate Gauging

Robust gauging under unstable conditions

Unique gauging methodology based on battery profile which is supported by chemical physics of composition in battery

Very Low Power Consumption

Extremely Low power consumption

Extremely low operational power consumption with optimized interval using "Dual Clock Architecture"

No-current Sense Resistor

Reduced BoM Count

No need for external current sensing resistor algorithm. Smaller footprint on PCB increases product designability and enhances cost benefits.

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Accurate Gauging

onsemi solution uses:

- Battery profile consists of unique look-up tables with parameters based on actual measurement and battery chemistry

- Internal battery resistance to enable stable gauging accuracy under various conditions
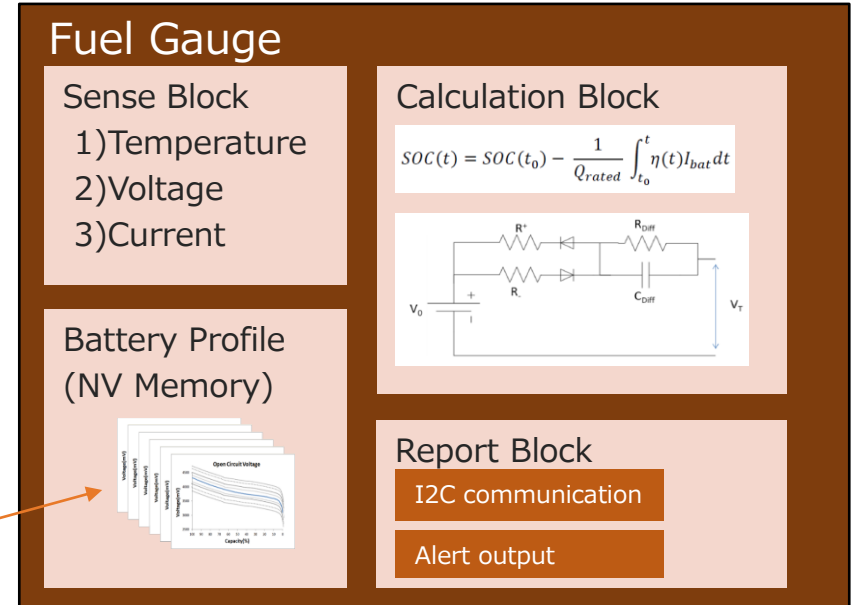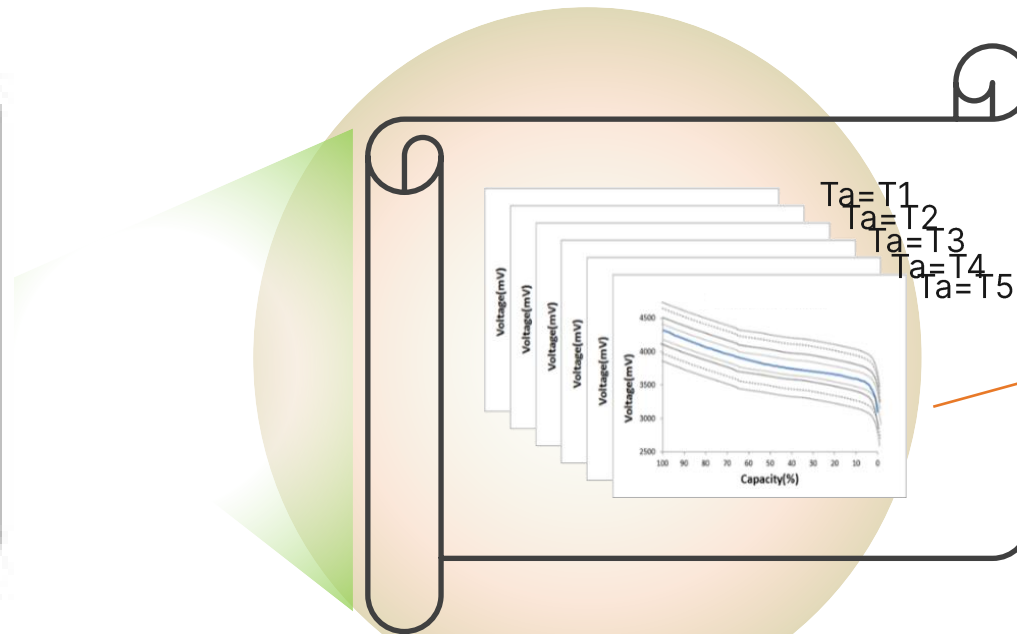
onsemi battery gauging is robust against:

- Battery aging from charge/discharge cycles

- Temperature fluctuation

- Charging voltage changes

Ta=T1
Ta=T2
Ta=T3
Ta=T4
Ta=T5

Fuel Gauge

Sense Block
1) Temperature
2) Voltage
3) Current

Calculation Block

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

Battery Profile (NV Memory)

Report Block

I2C communication

Alert output
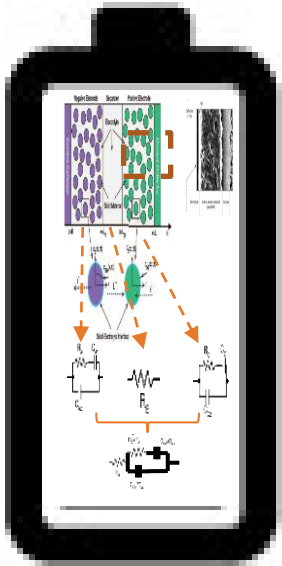
Battery Profile Table supports
Several parameters
-Charge current, -Discharge current
-Temperature, -Voltage shift from OCV

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Extremely Low Power Consumption
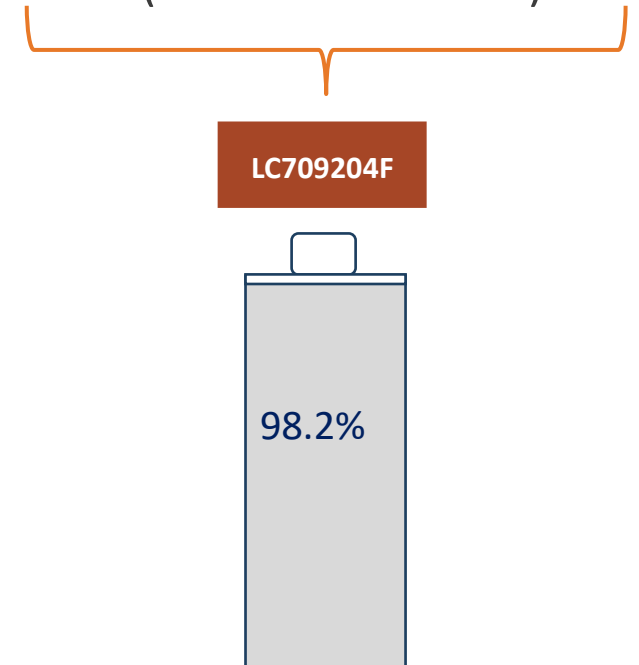
Power Consumption

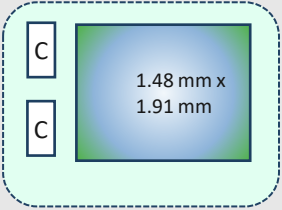|	LC709204F
Gauging Methodology	onsemi Technology
Supply Current (operation mode)	2 µA

- LC709204F only consumes 2 µA of operating current, noticeably lower
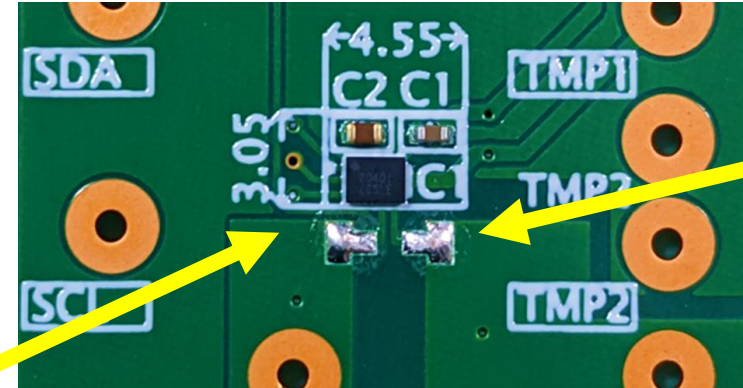- Power consumptions at operational mode is extremely low

Remaining Battery, when an end-product is stored in a warehouse for 30 days (calculated values)
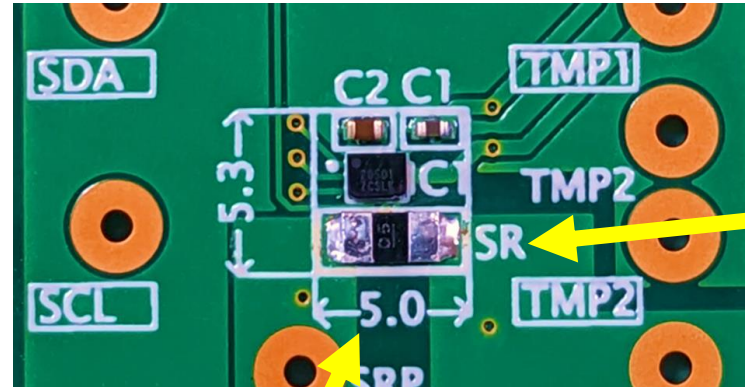
LC709204F

98.2%

(80 mAh Battery)

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No-current Sense Resistor

	onsemi LC709204F
Current Sensing Resistor	Not Required
External Part Count	Sense Resistor : 0 Resister : 0 Capacitor : 2
Footprint Image	C C 1.48 mm x 1.91 mm

Customer Benefits:
- No sense R becomes increasing important for wearables and small form factor applications.
- Its not just the sense R dimensions, the pcb footprint for the sense R is bigger than the sense R physical package dimensions.

No sense resistor

With sense resistor
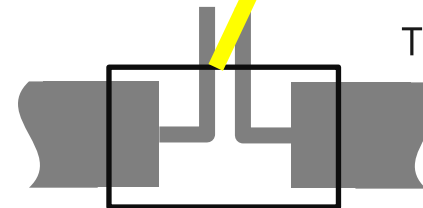
Typical Current Sense Resister (5 mΩ, 1%) :

PCB footprint: connection pattern

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onsemi Battery Sensing base model LC709204F

LC709204F

The standard model with the low power consumption and the small size in the industry, for safety and flexible size design, supports extensive enhanced alert functions

- External parts : 2pcs
- Lower Power : 2uA

Enhanced battery monitor report

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 Battery Sensing(Fuel Gauging) Solutions

Accurate Gauging
Robust Gauging under Unstable Battery Conditions

Extremely Power Consumption, Monitoring the Status of Operations

No-current Sense Resistor, Reduced BoM Count

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Support and Collateral

Data Sheet
Click Here

App Note
Click Here

Evaluation Board
Click Here

LC709204FXE-N01-GEVB

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Appendix

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LC709204F Product Overview
Battery Fuel Gauge with Low-Power 2 µA Operation

Unique Features	Benefits
HG-CVR2: Unique gauging methodology based on battery's chemical composition	Highly accurate and robust RSOC gauging
2 µA 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
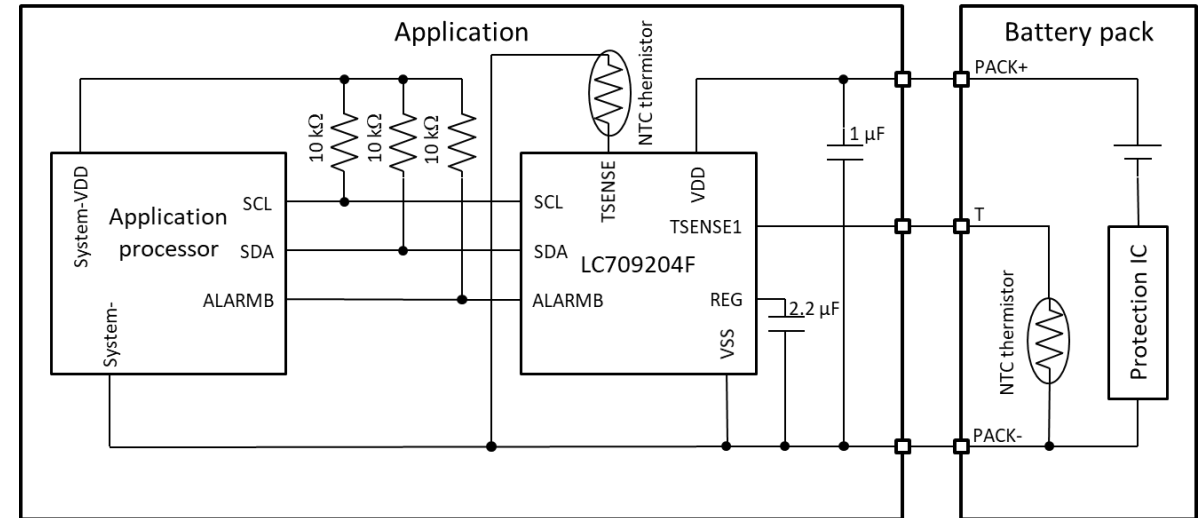
Ordering & Packaging Information

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

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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

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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	- Rescaled RSOC - Time to Empty - Time to Full - Ambient Temperature - Battery Status
Alarm Conditions	- High/Low Voltage - Low RSOC - High/Low Temperature - Over-Charge/Discharge Current [*1]
Battery Lifetime Reports	- 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.

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Thank you

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