bq34z100-G1 High Cell Count and High Capacity Applications

ABSTRACT
The bq34z100-G1 device is configurable to provide gauging for Li-Ion, Li-Polymer, LiFePO4, lead acid (PbA), NiMH and NiCd cell chemistries. The gauge can support charge and discharge currents up to 32 A, pack capacities up to 29 Ah, and pack voltages up to 65 V without special setups. This document provides information to setup the gauge to support packs that exceed these current, capacity, or voltage limits.

Contents
1 High-Voltage Batteries (> 65.535 V) ........................................................................................................ 2
1.1 Hardware Considerations ................................................................................................................... 2
1.2 Parameter Configuration Considerations .......................................................................................... 2
1.3 Does This Affect Gas Gauging? ................................................................................................. 3
2 High-Current Systems (> ±32 767 mA) ................................................................................................. 3
2.1 Hardware Considerations .................................................................................................................. 3
2.2 Parameter Configuration Considerations .......................................................................................... 3
2.3 How to Calibrate for Current Scaling .......................................................................................... 3
3 High-Capacity Systems (> 29 Ah) ........................................................................................................ 3
3.1 Parameter Configuration Considerations .......................................................................................... 3

List of Figures
1 BAT Resistor Divider .......................................................................................................................... 2

Impedance Track is a trademark of Texas Instruments.
All other trademarks are the property of their respective owners.
1 High-Voltage Batteries ( > 65.535 V)

This type of system requires additional attention to two areas which are voltage reporting and Impedance Track™ technology gauging.

1.1 Hardware Considerations

The input to the device (BAT pin) must be less than 1 V and therefore the external divider ratio should support the maximum pack voltage. Figure 1 shows the BAT resistor divider. For example, if an 18S Li-Ion pack is used, then the maximum pack voltage should be set to the recommended single-cell maximum voltage (for example, 5 V) times the actual number of series cells (for example 18) which is 90 V.

![Figure 1. BAT Resistor Divider](image)

Use Equation 1 to setup the voltage divider to support a 90-V pack voltage.

$$R_{\text{SERIES}} = 16 \, 500 \, \Omega \times \frac{(\text{Maximum Pack Voltage mV} - 900 \, \text{mV})}{900 \, \text{mV}}$$  \hspace{1cm} (1)

The second resistor in the resistor divider network should have a value between 15 kΩ and 25 kΩ. For this example, use 16.5 kΩ and Equation 2 to calculate the series resistance.

$$R_{\text{SERIES}} = 16 \, 500 \, \Omega \times \frac{(90 \, 000 \, \text{mV} - 900 \, \text{mV})}{900 \, \text{mV}} = 1.631 \, \text{MΩ}$$  \hspace{1cm} (2)

A standard value 1.62-MΩ resistor will support an 89-V pack voltage and provide adequate cell-voltage measurement margin for a Li-Ion cell.

1.2 Parameter Configuration Considerations

The data flash configuration must scale the pack voltage to ensure that the maximum reported voltage does not exceed 65 535 mV.

This additional scaling is created by scaling the value stored in number of series cells. Use Equation 3 to calculate the maximum pack voltage with the example values.

$$\frac{\text{Maximum Pack Voltage}}{\text{Maximum Reportable Value}} = \frac{90 \, 000 \, \text{mV}}{65 \, 535 \, \text{mV}} = 1.38$$  \hspace{1cm} (3)

The number of series cells is an integer unit so the scaling factor should be rounded up. For this example, use a 2x scaling factor.

$$\text{Stored Number of Cells} = \frac{\text{Actual Number of Cells} \times \text{Scaling Factor}}{2} = 18 \rightarrow 9$$  \hspace{1cm} (4)

The voltage must be divided by 2 when calibrating the voltage. For example, if the applied pack voltage is 80 V, then the designer should enter 40 000 mV in the program.

In this configuration, the host device that is reading the reported voltage value must also know that the voltage is scaled so that it can rescale the voltage to the true pack voltage.
NOTE: The actual number of series cells that can be scaled is limited. The result of the equation must be an integer. The result cannot be rounded up or down because this would cause the gauge to calculate the wrong cell voltage. As an example, if the actual number of series cells was 17, then the number of series cells must be set to 17 and the voltage will be reported as a single cell. The VOLTSEL bit must be set in the pack configuration register.

1.3 Does This Affect Gas Gauging?
The Impedance Track algorithm operates similarly to a single-cell battery. Therefore, with the scaling of the number of series cells, the voltage presented to the Impedance Track algorithm is representative of one cell.

2 High-CURRENT Systems (> ±32 767 mA)
The gauge can support charge and discharge currents up to 32 767 mA. Current scaling is required to support higher currents. High-current packs are typically high-capacity packs as well, so both the current and capacity may need to be considered when scaling the pack. The scale factor is calculated for both parameters and the largest scale factor is used for both parameters.

2.1 Hardware Considerations
To ensure accurate current measurement, the input voltage generated across the current-sense resistor should not exceed ±125 mV. The value of the sense resistor must be set to ensure that this voltage is not exceeded at the maximum charge and discharge current.

2.2 Parameter Configuration Considerations
The data flash configuration must scale the current to ensure that the maximum current does not exceed 32 768 mA. As an example, if the maximum discharge current is 64 A, then the scale factor is set to 64 000 mA / 32 768 mA = 1.95x or is rounded up to 2x. All current and capacity parameters in the data flash are divided by 2.

2.3 How to Calibrate for Current Scaling
The current must be scaled during the calibration phase. If 2x scaling is used, then the current is divided by 2. If a 4-A discharge current is used to calibrate the pack, then –2000 mA is entered as the actual current. All current and capacity parameters are reported at half the actual value and the host must multiply these parameters by the scale factor to find the true value.

3 High-Capacity Systems (> 29 Ah)
The gauge can support pack capacities up to 29 Ah. Current scaling is required to support higher capacities. High-capacity packs are typically high current packs as well, so both the current and capacity may need to be considered when scaling the pack. The scale factor is calculated for both parameters and the largest scale factor is used for both parameters.

3.1 Parameter Configuration Considerations
The data flash configuration must scale the capacity to ensure that the maximum capacity does not exceed 29 000 mAh. As an example, if the maximum pack capacity is 100 Ah, then the scale factor is set to 100 000 mAh / 29 000 mAh = 3.45x or rounded up to 4x. All current and capacity parameters in the data flash are divided by 4x.

3.1.1 How to Calibrate for Current Scaling
The current must be scaled during the calibration phase. If 4x scaling is used, then the current is divided by 4x. If a 16-A discharge current is used to calibrate the pack, then –4000 mA is entered as the actual current. All current and capacity parameters are reported at ¼ the actual value and the host will multiply these parameters by the scale factor to find the true value.
IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as "components") are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI's terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers' products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers' products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI’s goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or “enhanced plastic” are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have not been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

Products

<table>
<thead>
<tr>
<th>Audio</th>
<th><a href="http://www.ti.com/audio">www.ti.com/audio</a></th>
</tr>
</thead>
<tbody>
<tr>
<td>Amplifiers</td>
<td>amplifier.ti.com</td>
</tr>
<tr>
<td>Data Converters</td>
<td>dataconverter.ti.com</td>
</tr>
<tr>
<td>DLP® Products</td>
<td><a href="http://www.dlp.com">www.dlp.com</a></td>
</tr>
<tr>
<td>DSP</td>
<td>dsp.ti.com</td>
</tr>
<tr>
<td>Clocks and Timers</td>
<td><a href="http://www.ti.com/clocks">www.ti.com/clocks</a></td>
</tr>
<tr>
<td>Interface</td>
<td>interface.ti.com</td>
</tr>
<tr>
<td>Logic</td>
<td>logic.ti.com</td>
</tr>
<tr>
<td>Power Mgmt</td>
<td>power.ti.com</td>
</tr>
<tr>
<td>Microcontrollers</td>
<td>microcontroller.ti.com</td>
</tr>
<tr>
<td>RFID</td>
<td><a href="http://www.ti-ridf.com">www.ti-ridf.com</a></td>
</tr>
<tr>
<td>OMAP Applications Processors</td>
<td><a href="http://www.ti.com/omap">www.ti.com/omap</a></td>
</tr>
<tr>
<td>Wireless Connectivity</td>
<td><a href="http://www.ti.com/wirelessconnectivity">www.ti.com/wirelessconnectivity</a></td>
</tr>
</tbody>
</table>

Applications

| Automotive and Transportation | www.ti.com/automotive             |
| Communications and Telecom    | www.ti.com/communications        |
| Computers and Peripherals     | www.ti.com/computers             |
| Consumer Electronics          | www.ti.com/consumer-apps         |
| Energy and Lighting           | www.ti.com/energy                |
| Industrial                   | www.ti.com/industrial            |
| Medical                      | www.ti.com/medical               |
| Security                     | www.ti.com/security              |
| Space, Avionics and Defense   | www.ti.com/space-avionics-defense|
| Video and Imaging             | www.ti.com/video                 |

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2015, Texas Instruments Incorporated