ABSTRACT
This application report explains the implementation of a multi-cell lithium-ion the foundation of a battery management system using an TMS570™ microcontroller and the bq76PL455A-Q1.

Introduction
The bq76PL455A-Q1 can be stacked vertically to monitor up to 192 cells without additional isolation components between ICs. A high-speed universal asynchronous receiver/transmitter (UART) bus operates between the bottom bq76PL455A-Q1 and the TMS570LS0432 microcontroller. The differential communication interface provided by the bq76PL455A-Q1 is used to provide reliable communications through all bq76PL455A-Q1 devices in a high-voltage battery cell stack.

This firmware provided with this application note provides source code examples of the command sequences described in the bq76PL455A-Q1 Software Design Reference document (SLVA617).

Sample application code and other information associated with this application report can be downloaded from SLUC270.

2 Conventions and Acronyms
This section describes the conventions and acronyms used in this document.

2.1 Conventions
'0' Binary digit zero; a logic low level (a low voltage for active high logic, and a high voltage for active low logic)
'1' Binary digit one; a logic high level (a high voltage for active high logic, and a low voltage for active low logic)
"d..." A binary number with more than one digit (d is 0-1)
d... A decimal number (d is 0-9)
0xd... A hexadecimal number (d is 0-F)
d...h A hexadecimal number (d is 0-F)
2.2 Acronyms

ADC  Analog to Digital Converter  
AFE  Analog Front End  
API  Application Programmers Interface  
BMS  Battery Management System  
BSP  Battery Stack Protection  
CAN  Controller Area Network  
DAC  Digital to Analog Converter  
EEPRO  Electrically Erasable Programmable Read Only Memory  
MCU  Micro-Controller Unit  
Module  Series connection of cells managed by a single bq76PL455A-Q1 in the BMS  
OC  Over Current  
OV  Over Voltage  
OVP  Over Voltage Protection  
PWM  Pulse Width Modulation  
Stack  Series connection of all cells managed by the BMS  
SPI  Serial Peripheral Interface  
UV  Under Voltage  
UVP  Under Voltage Protection  

3 Hardware

The system is implemented using the TMS570LS Launchpad board (TMS570LS0432 MCU) and the BQ76PL455EVM. Figure 1 shows the system block diagram. For more information on these devices, see the device datasheets.

The evaluation modules' part numbers are LAUNCHXL-TMS57004 and BQ76PL455EVM. These boards are available from the TI eStore (https://estore.ti.com/) or from your local TI sales representative. For more details and information related to these evaluation modules (EVMs), see the specific EVM user's guide.
Figure 1. System Block Diagram
3.1 Connecting the Evaluation Modules

The EVMs are connected using standard wire jumper; Table 1 shows the connections between the two EVMs. By default, the TMS570 Launchpad is powered by the USB port on the host computer and the BQ76PL455EVM is powered by a 3.3-V regulator on the TMS570 Launchpad board.

NOTE: Make sure that the resistor R8 is removed on the TMS570 Launchpad board.

<table>
<thead>
<tr>
<th>Connection Name</th>
<th>BQ76PL455EVM</th>
<th>TMS570 Launchpad</th>
</tr>
</thead>
<tbody>
<tr>
<td>TX</td>
<td>J3 pin 5</td>
<td>J1 pin 3 (SCI1_RX)</td>
</tr>
<tr>
<td>RX</td>
<td>J3 pin 4</td>
<td>J1 pin 4 (SCI1_TX)</td>
</tr>
<tr>
<td>nWAKE</td>
<td>J3 pin 6</td>
<td>J2 pin 3 (GIOA0)</td>
</tr>
<tr>
<td>nFAULT</td>
<td>J3 pin 2</td>
<td>J2 pin 4 (GIOA1)</td>
</tr>
<tr>
<td>VIO</td>
<td>J3 pin 3</td>
<td>J1 pin 1 (+3V3)</td>
</tr>
<tr>
<td>GND</td>
<td>J3 pin 1</td>
<td>J2 pin 1 (DGND)</td>
</tr>
</tbody>
</table>

3.2 Communication

The example code only provides a control interface to the bq76PL455A-Q1 and does not provide any other communications interface to the outside world. It is expected that the customer come up with their own communication implementation. Examples of communications interfaces available to the TMS570 are SPI, CAN or UART.

4 Software

The software provides command API and drivers that implement the examples provided in the bq76PL455A-Q1 Software Design Reference document. There are comments in the source code that explain the section in the bq76PL455A-Q1 Software Design Reference document the example refers to.

Importing Project into Code Composer Studio

1. Launch provided file: BQ76PL455_Example_Code_installer.exe and extract files to default path provided (C:\ti\bq76PL455A-Q1 Example Code 1.0).
2. Launch Code Composer Studio (CCS):
   - Start → Programs → Texas Instruments → Code Composer Studio v5 → Code Composer Studio v5
3. When it launches, CCS will ask you to select a workspace, we will choose “C:\myWorkspace”. Once CCS loads, go to:
   - File → Import → Code Composer Studio → Existing CCS Eclipse Projects
4. In Select search-directory: Browse to the folder C:\ti\bq76PL455A-Q1 Example Code 1.0
5. In Discovered projects: Check TMS570LS04x_455
## Revision History

<table>
<thead>
<tr>
<th>DATE</th>
<th>REVISION</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>September 2015</td>
<td>*</td>
<td>Initial release.</td>
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