Application Report
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2-Series-Cell Considerations for Advanced Fuel Gauges

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ABSTRACT

TI Advanced fuel gauges, primarily designed for notebook computer applications, is used with 2-, 3-, or 4-series cells. However, the 2-cell case has some special considerations of which battery pack designers should be aware. This report covers evaluation and design issues along with their solutions.

1 Initial Evaluation Setup

Evaluation modules (EVM) are supplied with default dataflash settings for 4-series cells. Use either bqEASY feature of the bqEV-EASY evaluation software, or follow the guidelines in the application book entitled *bq20zxx EVM Data Flash Settings for Number of Serial Cells and Pack Capacity*. This application report can also be found by searching for TI literature number SLVA208. If not using the bqEASY, there are changes to be made to the following data parameter classes: First Level Safety, Second Level Safety, Charge Control, SBS Configuration, Power, and Gas Gauging.

The most common problem associated with this process occurs when trying to modify the dataflash while using 2-series-cells that provide less than 7500 mV to the gauge. Warning messages indicate that the flash memory is inaccessible – the voltage is too low. The default value for **Flash Update OK Voltage** is 7500 mV, but should be modified to approximately 6000 mV for the 2-series cell case. The solution provides a battery voltage higher than 7500 mV in order to gain access to dataflash editing.

2 Design and Development

2.1 Battery Connections

The 2-series cell schematic should look just like the 3- or 4-series cell design except that VC1, VC2 and VC3 are connected together on both the AFE/Gauge and secondary voltage protector. An example schematic for the bq20z95 is shown in Figure 1. There are no other changes necessary for a 2-series cell pack.

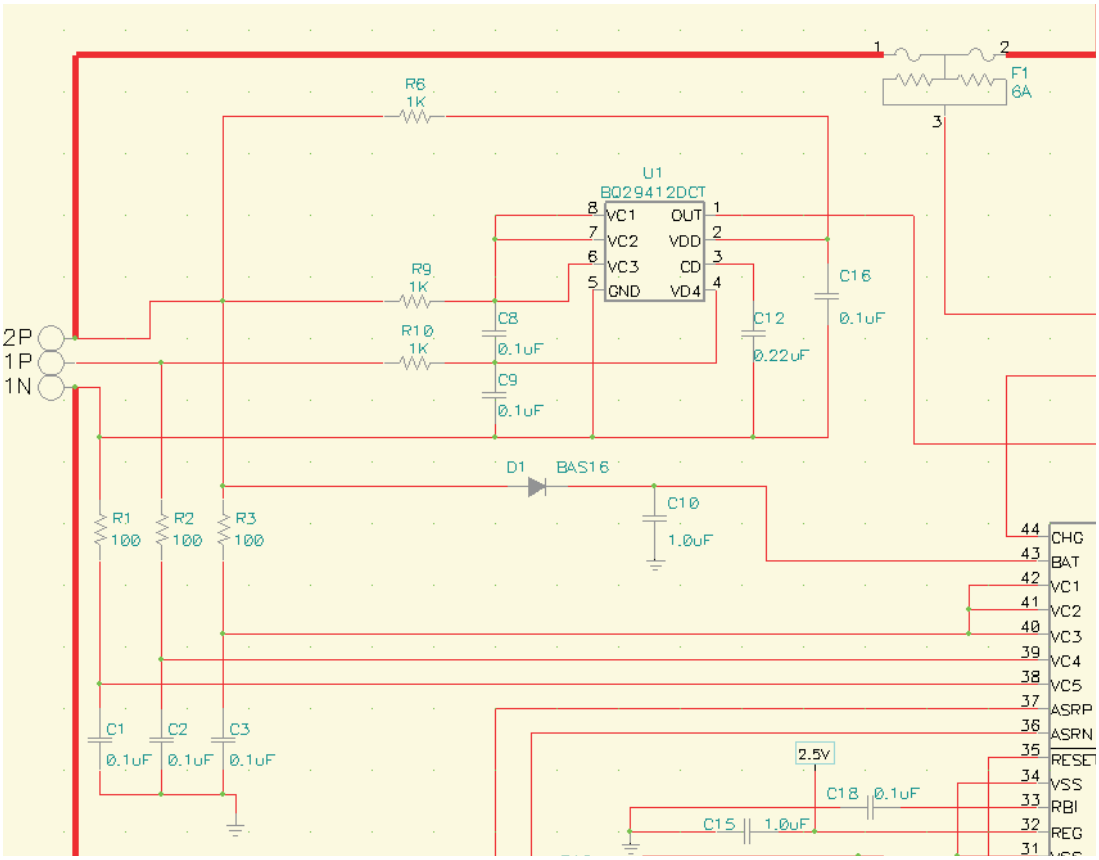

Figure 1. 2-Series Cell Design Has VC1, VC2 and VC3 Pins Shorted on 2nd Voltage Protector and Fuel Gauge Battery Inputs.

2.2 Low Voltage Considerations for Discharge FET Gate Drive

For advanced fuel gauges employing N-channel protection FETs, the gate is turned on from the voltage generated in an internal charge pump. Its important to remember that the fuel gauge is only specified to work down to a supply voltage of 4.5V. This requires careful consideration of what could happen during an undervoltage condition.

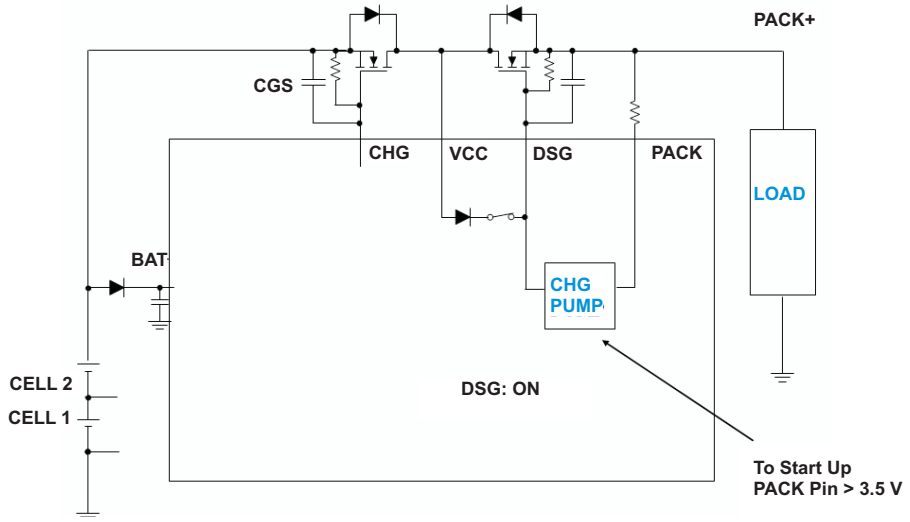

Figure 2. Simplified Drawing of Gate Drive Circuit for Discharge FET

Normal cell undervoltage protection is shown below in Figure 3. As the cell voltage decays, the programmable CUV voltage threshold is detected at point A. Then there is a programmable delay followed by the firmware command to turn off the discharge FET at point B.

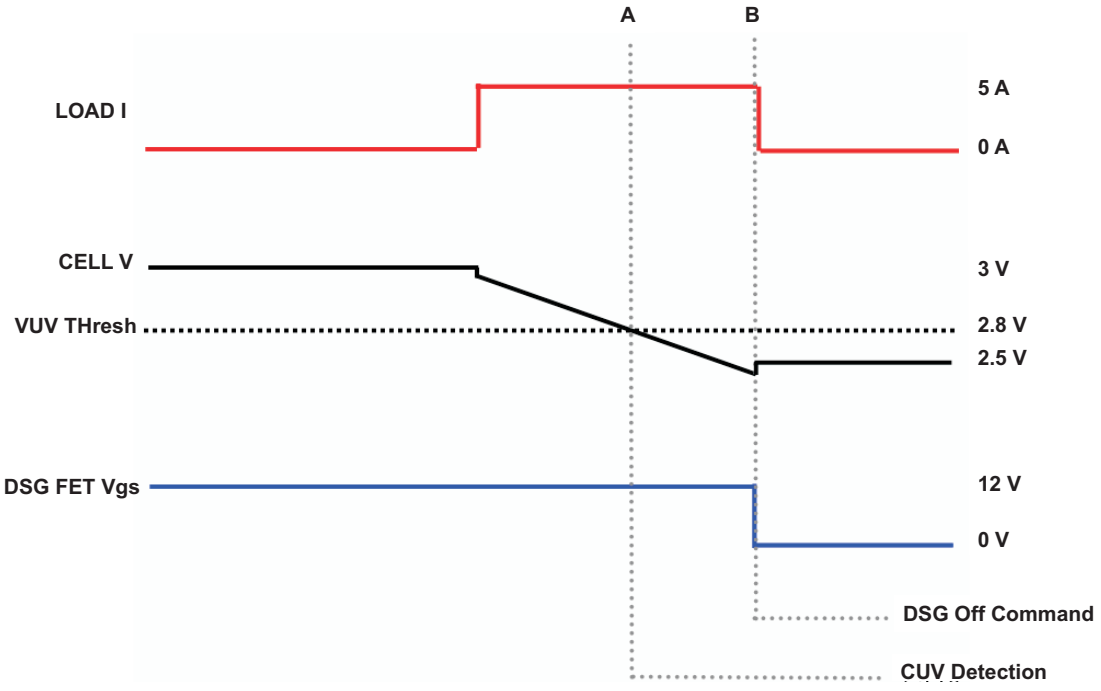

Figure 3. Normal Cell Undervoltage Protection

However, consider the example where the cells are extremely depleted and cell voltage is dropping rapidly during the delay period between CUV threshold and the turn off command. In Figure 4, the cell voltage (half of the pack voltage in this case) at point B crosses the threshold of 1.75 volts where the charge pump can no longer operate properly. The charge pump is starved, placing the protection FET into linear operation and possible thermal damage.

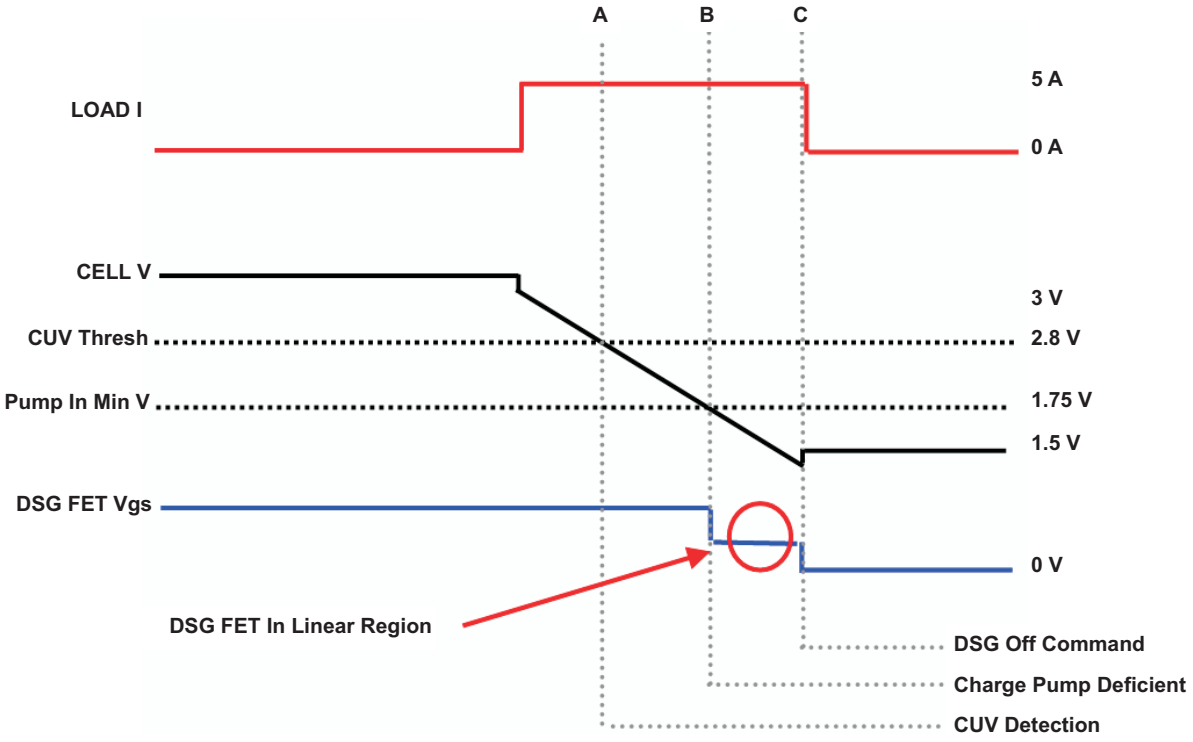

Figure 4. Abnormal Cell Undervoltage Protection

Avoid the problem by observing the following guidelines when setting cell undervoltage parameters in a 2-series cell application:

- Set CUV and PUV protection thresholds as high as possible to ensure enough capacity to run the charge pump.
- Set CUV and PUV delays as low as possible (1sec) to insure quick turn-off when battery voltage is falling.
- Set CUV and PUV recovery thresholds as high as possible to avoid FET turn-on problems if significant load is present during recovery. Fortunately, most systems are designed to avoid demanding heavy current when voltage is too low for normal operation.
- The bq20z70/75/90/95 chipset is only specified to work down to 4.5V.
- Test the application extensively !

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