Features

- bq2031 fast-charge control evaluation and development
- Onboard configuration for fast charge of 2, 3, 4 or 6 lead-acid cells; user-defined option allows other configurations
- Selectable charge algorithms: Two-Step Voltage, Two-Step Current, or Pulsed Current
- Constant current (up to 2.2A) and constant voltage (up to 15V) provided by on-board switch-mode regulator
- Charge termination by maximum voltage, second difference of cell voltage, minimum current, or maximum time-out
- Direct connections for battery, thermistor, and power supply
- MTO is set for 3.1 hours
- Jumper-configurable 3-LED display

General Description

The DV2031S2 Development System provides a development environment for the bq2031 Lead-Acid Fast-Charge IC. The DV2031S2 incorporates a bq2031 in a buck-type switch-mode regulation mode to provide fast-charge control for 2, 3, 4, or 6 lead-acid cells.

The DV2031S2 can be configured for three different charge algorithms with jumpers JP1 and JP3. The charge algorithms available are:

- Two-step voltage
- Two-step current
- Pulsed current

Each algorithm consists of pre-charge qualification, fast charge, and maintenance charge periods.

Fast charge termination occurs on:

- Maximum voltage
- The second difference of cell voltage (Δ²V)
- Minimum current
- Maximum time-out

The maintenance charge may be configured for either a regulated float voltage or a pulsed current.

The user provides a DC power supply and batteries and configures the board for the number of cells, the minimum current threshold, and the LED display mode. The board has direct connections for the battery and the provided thermistor.

Before using the DV2031S2 board, please review the bq2031 data sheet (SLUS156) and the application note entitled “Using the bq2031 to Charge Lead-Acid Batteries” (SLUA017).

Please be aware that three important notices concerning operating limitations, standard warranty, and liability limitations appear at the end of this data sheet.
Connection Descriptions

TB1
- **DC+**  Charger supply (DC) 30V MAX
- **DC−**  Ground from charger supply and low side of system load

TB2
- **BAT+**  Positive battery terminal
- **BAT−**  Negative battery terminal
- **TEM−**  Thermistor connection (negative)
- **TEM+**  Thermistor connection (positive)

JP1 QSEL  Charge algorithm select
JP2 DSEL  Display mode select
JP3 TSEL  Charge algorithm select
JP4 IGSEL  Minimum current select
JP5  Number of cells

Fixed Configuration

The DV2031S2 board has the following fixed characteristics:

- \( V_{CC} \) for the fast charge IC is regulated on-board from the supply at connector TB1. TB1 can accept a maximum of 30VDC. The minimum charging voltage for two cells is 10VDC, and the minimum charging voltage for six cells is 22VDC.
- LED1 and LED2 indicate charge status.
- LED3 indicates a charge-pending or fault condition.
- Charge begins on the later application of:
  1. The battery
  2. Supply voltage

The onboard regulator supplies a fast charge current \( I_{MAX} \) of 2.2A. The fast (bulk) charge voltage \( V_{BLK} \) is set at 2.45V per cell (±1%) and the float voltage \( V_{FLT} \) is set at 2.25V per cell (±1%).

The number of cells can be changed within board-defined parameters, as described below in “Jumper-Selectable Configuration.”

The switching frequency of the PWM control is 100kHz.

The regulated current is controlled by the value of the sense resistor \( R_{SENS} \) according to the equation

\[
I_{CHG} = \frac{0.25V}{R_{SENS}}
\]

The value of \( R_{SENS} \) (R20 in the schematic) at shipment is 0.120Ω. This resistor can be changed depending on the application. The suggested maximum charging current \( I_{MAX} \) for the bq2031S1 board is 2.2A with an accuracy of ±10%.

The thermistor provided is the Philips 2322–640–63103. With this thermistor connected between TEM+ and TEM−, the temperature fault limits are \( V_{LTF} \) (low temperature fault) = 0°C, \( V_{HTF} \) (high temperature fault) = 45°C, and \( V_{TCO} \) (charge cutoff) = 47°C.

Jumper-Selectable Configuration

The DV2031S2 must be configured as follows:

- **DSEL** (JP2) selects the LED display options as described in Table 1 on the following page.
- **TSEL** (JP3) and **QSEL** (JP1) select the charge algorithm as shown in Table 2 on the following page.
- **IGSEL** (JP4) sets \( I_{MIN} \) and the Two-Step Current maintenance charge as a ratio of \( I_{MAX} \): \( I_{COND} = \frac{I_{MAX}}{5} \), as shown below:

<table>
<thead>
<tr>
<th>JP4</th>
<th>( I_{MIN} )</th>
<th>Fixed-Pulse Average Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>( I_{MIN} )</td>
<td>( I_{MIN} = \frac{I_{MIN}}{2} )</td>
</tr>
<tr>
<td>H</td>
<td>( I_{MIN} )</td>
<td>( I_{MIN} = \frac{I_{MIN}}{2} )</td>
</tr>
<tr>
<td>None</td>
<td>( I_{MIN} )</td>
<td>( I_{MIN} = \frac{I_{MIN}}{2} )</td>
</tr>
</tbody>
</table>

As indicated in the Jumper Configuration Diagram, JP5 configures the board for the number of lead-acid cells.
Table 1. bq2031 LED Display Output Summary

<table>
<thead>
<tr>
<th>Mode</th>
<th>Charge Action State</th>
<th>LED₁</th>
<th>LED₂</th>
<th>LED₃</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>Battery absent or over-voltage fault</td>
<td>Low</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Pre-charge qualification</td>
<td>Flash</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Fast charging</td>
<td>High</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Maintenance charging</td>
<td>Low</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Charge pending (temperature out of range)</td>
<td>X</td>
<td>X</td>
<td>Flash</td>
</tr>
<tr>
<td></td>
<td>Charging fault</td>
<td>X</td>
<td>X</td>
<td>High</td>
</tr>
<tr>
<td>H</td>
<td>Battery absent or over-voltage fault</td>
<td>Low</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Pre-charge qualification</td>
<td>High</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Fast charge</td>
<td>Low</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Maintenance charging</td>
<td>High</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Charge pending (temperature out of range)</td>
<td>X</td>
<td>X</td>
<td>Flash</td>
</tr>
<tr>
<td></td>
<td>Charging fault</td>
<td>X</td>
<td>X</td>
<td>High</td>
</tr>
<tr>
<td>None</td>
<td>Battery absent or over-voltage fault</td>
<td>Low</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Pre-charge qualification</td>
<td>Flash</td>
<td>Flash</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Fast charge: current regulation</td>
<td>Low</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Fast charge: voltage regulation</td>
<td>High</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Maintenance charging</td>
<td>High</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Charge pending (temperature out of range)</td>
<td>X</td>
<td>X</td>
<td>Flash</td>
</tr>
<tr>
<td></td>
<td>Charging fault</td>
<td>X</td>
<td>X</td>
<td>High</td>
</tr>
</tbody>
</table>

Notes: 1 = V_CC; 0 = V_SS; X = LED state when fault occurred; Flash = ½ s low, ½ s high.

In the Pulsed Current algorithm, the bq2031 annunciates maintenance when charging current is off and fast charge whenever charging current is on.

Table 2. Charge Algorithms

<table>
<thead>
<tr>
<th>JP1</th>
<th>JP3</th>
<th>Fast Charge</th>
<th>Termination</th>
<th>Maintenance</th>
</tr>
</thead>
<tbody>
<tr>
<td>L∪</td>
<td>H∪or L∪</td>
<td>Two-Step Voltage[]</td>
<td>I_MINP[&lt;]MTO[]</td>
<td>Constant[voltage]&lt; VFLT</td>
</tr>
<tr>
<td>H</td>
<td>L</td>
<td>Two-Step Current</td>
<td>V_BLK or ∆V or MTO</td>
<td>Fixed-pulse current at ICOND</td>
</tr>
<tr>
<td>H</td>
<td>H</td>
<td>Pulsed Current</td>
<td>V_BLK (see Note)</td>
<td>Fast-charge rate when V_BLK ≤ VFLT</td>
</tr>
</tbody>
</table>

Note: Fast-charge termination by MTO is a fault.
**Setup Procedure**

1. Configure DSEL, TSEL, QSEL, maximum time-out, and the number of cells.
2. Connect the thermistor to TEM+ and TEM–.
3. Attach the battery pack to BAT+ and BAT–.
4. Connect the charging supply to TB1 (DC+, DC-).

The combined charging and system load should not exceed the $I_{MAX}$ limit of 2.2A.
EVM WARNINGS AND RESTRICTIONS

It is important to operate this EVM within the input voltage range of 30 V and the output voltage range of 21 V and 4.6 V.

Exceeding the specified input range may cause unexpected operation and/or irreversible damage to the EVM. If there are questions concerning the input range, please contact a TI field representative prior to connecting the input power.

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Post Office Box 655303
Dallas, Texas 75265

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