Features

➤ bq2031 fast-charge control evaluation and development
➤ Accepts AC (21V RMS max.) or DC (30V max.) inputs
➤ Onboard configuration for fast charge of 3 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 2.5A) 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 reset signal
➤ Jumper-configurable three-LED display

General Description

The DV2031S1 Development System provides a development environment for the bq2031 Lead-Acid Fast-Charge IC. The DV2031S1 incorporates a bq2031 and a buck-type switch-mode regulator to provide fast charge control for 3 or 6 lead-acid cells.

The DV2031S1 can be configured for three different charge algorithms with jumpers JP2 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 (Δ√V)
- Minimum current

Maximum time-out

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

The bq2031 can be reset and a new charge cycle started with either the momentary on-board switch (SW1) or via the INH input on connector J2. The reset signal simulates a “Battery Absent” condition. Charging is inhibited as long as the reset signal is active; once it is released, the charge cycle re-starts at pre-charge qualification.

The user provides a power supply (AC or DC) and batteries and configures the board for the number of cells, the maximum time-out period, the minimum current threshold, and the LED display mode. The board has direct connections for the battery and the provided thermistor.

Before using the DV2031S1 board, please review the bq2031 data sheet and the application note entitled “Using the bq2031 to Charge Lead-Acid Batteries”.
Connection Descriptions

J1 Charger supply (AC): 21 RMS MAX
J2 INH Charge inhibit signal
BAT+ Positive battery terminal
BAT– Negative battery terminal
TS+, TS– Thermistor connections
LOAD+ High side of system load
DC_RTN Ground from charger supply and low side of system load
DC_IN Charger supply (DC): 30V MAX
JP1 DSEL Display mode select
JP2 TSEL Termination select
JP3 QSEL Charge algorithm select
JP4 IGSEL Minimum current select
HD1 TMTO Maximum time-out select
HD2 BAT Number of cells select
S1 Charge inhibit switch

Fixed Configuration

The DV2031S1 board has the following fixed characteristics:

VCC for the fast charge IC is regulated on-board from the supply at connector J1 or J2. J1 can accept a maximum of 21VAC RMS and J2 can accept a maximum of 30VDC. The minimum charging voltage for three cells is 9VAC or 13VDC, and the minimum charging voltage for six cells is 18VAC or 25VDC.

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 IMAX of 2.75A. The fast (bulk) charge voltage VBLK and the float maintenance voltage VFLT are set at 25°C as:

<table>
<thead>
<tr>
<th>Number of Cells</th>
<th>VBLK</th>
<th>VFLT</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>2.45</td>
<td>2.28V</td>
</tr>
<tr>
<td>6</td>
<td>2.47</td>
<td>2.27V</td>
</tr>
</tbody>
</table>

The number of cells, VBLK, and VFLT can be adjusted as described in the next section.

The switching frequency of the PWM control loops is 100kHz.

The regulated current is controlled by the value of the sense resistor RSN by the relationship:

$$I_{CHG} = \frac{0.25V}{R_{SN}}$$

The value of RSN (R31 in the schematic) at shipment is 0.100Ω. This resistor can be changed depending on the application. The suggested maximum charging current IMAX for the bq2031S1 board is 2.5A with an accuracy of ±10%.

The thermistor provided is the Philips 2322-640-63103. With this thermistor connected between TS+ and TS–, the temperature fault limits are VLT (low temperature fault) = 0°C, VHT (high temperature fault) = 45°C, and VTCO (charge cutoff) = 47°C.
The DV2031S1 must be configured as follows:

**Jumper-Selectable Configuration**

The DV2031S1 must be configured as follows:

DSEL (JP1): Selects the LED display options as described in the data sheet.

TSEL (JP2) and QSEL (JP3): Select the charge algorithm.

IGSEL (JP4): Sets IMIN and the Two-Step Current maintenance charge as a ratio of IMAX. \( I_{COND} = \frac{I_{MAX}}{5} \).

TMTO (HD1): Sets the maximum time-out period (MTO).

BAT (HD2): Configures the board for the number of lead-acid cells.

### Jumper-Selectable Configuration

The user selectable option can be used for series configurations of 2 to 6 cells or to change \( V_{FLT} \) or \( V_{BLK} \). Jumper setting HD2[5 6] requires the appropriate sizing of R22 depending on the following equations:

**Equation 1**

\[
\frac{R_A}{R_{19}} = \left( \frac{N \cdot V_{FLT}}{22} \right) - 1
\]

**Equation 2**

\[
\frac{R_A}{R_{34}} = \left( \frac{N \cdot V_{BLK}}{22} \right) - 1
\]

where \( N \) = number of cells and \( R_A = R_{22} + R_{25} \). The DV2031S1 board comes with \( R_{19} = 49.9K \), \( R_{25} = 10K \), and \( R_{34} = 464K \).

### Charge Algorithms

<table>
<thead>
<tr>
<th>JP2</th>
<th>JP3</th>
<th>Fast Charge</th>
<th>Termination</th>
<th>Maintenance</th>
</tr>
</thead>
<tbody>
<tr>
<td>[1 2] 3 or 1 [2 3]</td>
<td>1 [2 3]</td>
<td>Two-Step Voltage</td>
<td>( I_{MIN} ) or MTO</td>
<td>Constant voltage at ( V_{FLT} )</td>
</tr>
<tr>
<td>[1 2] 3</td>
<td>[1 2] 3</td>
<td>Pulsed Current</td>
<td>( V_{BLK} ) or MTO</td>
<td>Fast charge rate when ( V_{BAT} &lt; V_{FLT} ), until ( V_{BAT} = V_{MAX} )</td>
</tr>
<tr>
<td>1 [2 3]</td>
<td>[1 2] 3</td>
<td>Two-Step Current</td>
<td>( V_{BLK} ) or ( V_{BLK} \Delta V ) or MTO</td>
<td>Fixed-pulse current at ( I_{COND} )</td>
</tr>
</tbody>
</table>

### Setup Procedure

1. Configure DSEL, TSEL, QSEL, maximum time-out, and the number of cells.
2. Connect the thermistor to TS+ and TS–.
3. Attach the battery pack to BAT+ and BAT–.
4. Connect the charging supply to J1 (AC) or J2 (DC).

The combined charging supply or J1 (AC) or J2 (DC).

The combined charging supply to J1 (AC) or J2 (DC).

The combined charging supply should not exceed the \( I_{MAX} \) limit of 2.5A.

### Table: HD2 Number of Cells

<table>
<thead>
<tr>
<th>HD2</th>
<th>Number of Cells</th>
</tr>
</thead>
<tbody>
<tr>
<td>[1 2] 3 4 5 6</td>
<td>3</td>
</tr>
<tr>
<td>1 2 [3 4] 5 6</td>
<td>6</td>
</tr>
<tr>
<td>1 2 3 4 [5 6]</td>
<td>User selectable</td>
</tr>
</tbody>
</table>
IMPORTANT NOTICE

Texas Instruments and its subsidiaries (TI) reserve the right to make changes to their products or to discontinue any product or service without notice, and advise customers to obtain the latest version of relevant information to verify, before placing orders, that information being relied on is current and complete. All products are sold subject to the terms and conditions of sale supplied at the time of order acknowledgement, including those pertaining to warranty, patent infringement, and limitation of liability.

TI warrants performance of its semiconductor products to the specifications applicable at the time of sale in accordance with TI’s standard warranty. Testing and other quality control techniques are utilized to the extent TI deems necessary to support this warranty. Specific testing of all parameters of each device is not necessarily performed, except those mandated by government requirements.

CERTAIN APPLICATIONS USING SEMICONDUCTOR PRODUCTS MAY INVOLVE POTENTIAL RISKS OF DEATH, PERSONAL INJURY, OR SEVERE PROPERTY OR ENVIRONMENTAL DAMAGE (“CRITICAL APPLICATIONS”). TI SEMICONDUCTOR PRODUCTS ARE NOT DESIGNED, AUTHORIZED, OR WARRANTED TO BE SUITABLE FOR USE IN LIFE-SUPPORT DEVICES OR SYSTEMS OR OTHER CRITICAL APPLICATIONS. INCLUSION OF TI PRODUCTS IN SUCH APPLICATIONS IS UNDERSTOOD TO BE FULLY AT THE CUSTOMER’S RISK.

In order to minimize risks associated with the customer’s applications, adequate design and operating safeguards must be provided by the customer to minimize inherent or procedural hazards.

TI assumes no liability for applications assistance or customer product design. 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 of TI covering or relating to any combination, machine, or process in which such semiconductor products or services might be or are used. TI's publication of information regarding any third party’s products or services does not constitute TI’s approval, warranty or endorsement thereof.

Copyright © 1999, Texas Instruments Incorporated