

Lead-Acid Charger Development System

Control of On-Board P-FET Switch-Mode Regulator

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 2.5A) 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 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 (Δ^2V)
- 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.

DV2031S2

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 2.5A. 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_{SNS} according to the equation

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

The value of R_{SNS} (R20 in the schematic) at shipment is 0.10Ω. This resistor can be changed depending on the application. The suggested maximum charging current I_{MAX} 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 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} = I_{MAX}/5, as shown below:

JP4	I _{MIN}	Fixed-Pulse Average Current
L	I _{MAX} /10	I _{COND} /2 = I _{MAX} /10
H	I _{MAX} /20	I _{COND} /4 = I _{MAX} /20
None	I _{MAX} /30	I _{COND} /8 = I _{MAX} /30

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

Mode	Charge Action State	LED ₁	LED ₂	LED ₃
L	Battery absent or over-voltage fault	Low	Low	High
	Pre-charge qualification	Flash	Low	Low
	Fast charging	High	Low	Low
	Maintenance charging	Low	High	Low
	Charge pending (temperature out of range)	X	X	Flash
	Charging fault	X	X	High
H	Battery absent or over-voltage fault	Low	Low	High
	Pre-charge qualification	High	High	Low
	Fast charge	Low	High	Low
	Maintenance charging	High	Low	Low
	Charge pending (temperature out of range)	X	X	Flash
	Charging fault	X	X	High
None	Battery absent or over-voltage fault	Low	Low	High
	Pre-charge qualification	Flash	Flash	Low
	Fast charge: current regulation	Low	High	Low
	Fast charge: voltage regulation	High	High	Low
	Maintenance charging	High	Low	Low
	Charge pending (temperature out of range)	X	X	Flash
	Charging fault	X	X	High

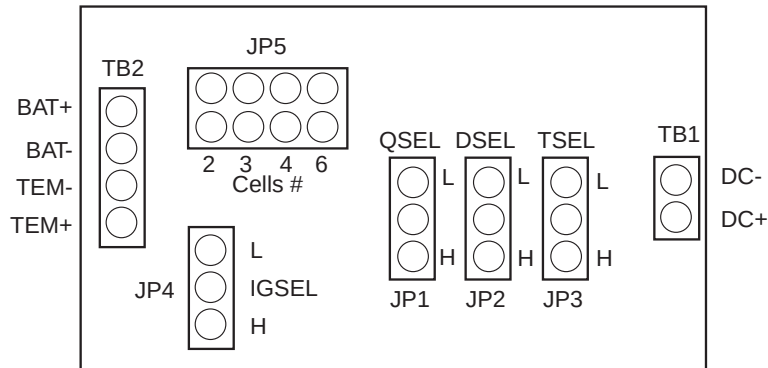
Notes: 1 = V_{CC}; 0 = V_{SS}; X = LED state when fault occurred; Flash = 1/2 s low, 1/2 s high.
 In the Pulsed Current algorithm, the bq2031 annunciates maintenance when charging current is off and fast charge whenever charging current is on.

Table 2. Charge Algorithms

JP1	JP3	Fast Charge	Termination	Maintenance
L	H or L	Two-Step Voltage	I _{MIN} or MTO	Constant voltage at V _{FLT}
H	L	Two-Step Current	V _{BLK} or Δ^2V or MTO	Fixed-pulse current at I _{COND}
H	H	Pulsed Current	V _{BLK} (see Note)	Fast-charge rate when V _{BLK} ≤ V _{FLT}

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

Jumper Configuration Diagram



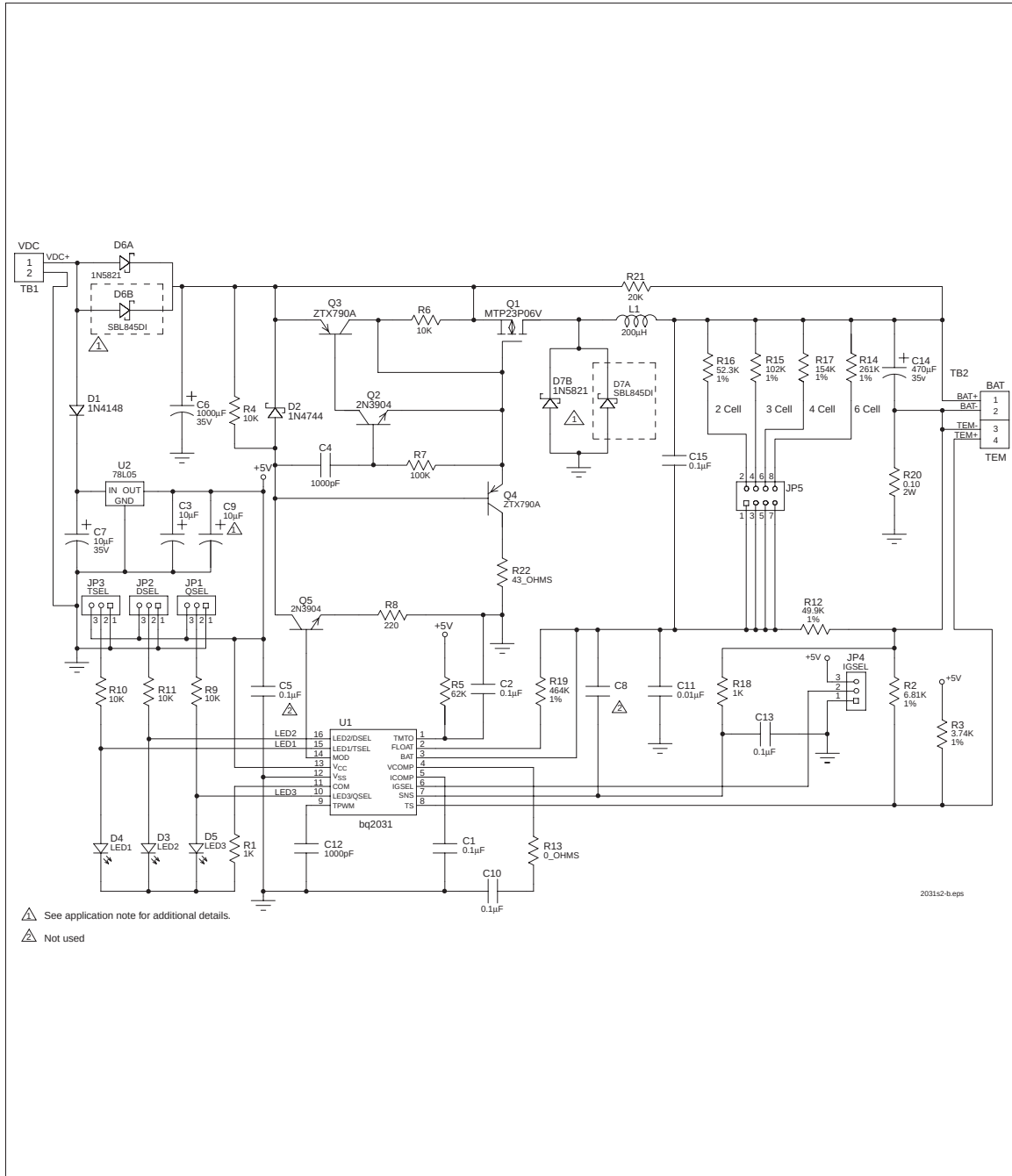
JC2031.eps

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 2.5A.

DV2031S2 Board Schematic



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.

Applying loads outside of the specified output range may result in unintended operation and/or possible permanent damage to the EVM. Please consult the EVM User's Guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative.

During normal operation, some circuit components may have case temperatures greater than 60°C. The EVM is designed to operate properly with certain components above 60°C as long as the input and output ranges are maintained. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors. These types of devices can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during operation, please be aware that these devices may be very warm to the touch.

Mailing Address:

Texas Instruments
Post Office Box 655303
Dallas, Texas 75265

EVM IMPORTANT NOTICE

Texas Instruments (TI) provides the enclosed product(s) under the following conditions:

This evaluation kit being sold by TI is intended for use for **ENGINEERING DEVELOPMENT OR EVALUATION PURPOSES ONLY** and is not considered by TI to be fit for commercial use. As such, the goods being provided may not be complete in terms of required design-, marketing-, and/or manufacturing-related protective considerations, including product safety measures typically found in the end product incorporating the goods. As a prototype, this product does not fall within the scope of the European Union directive on electromagnetic compatibility and therefore may not meet the technical requirements of the directive.

Should this evaluation kit not meet the specifications indicated in the EVM User's Guide, the kit may be returned within 30 days from the date of delivery for a full refund. THE FOREGOING WARRANTY IS THE EXCLUSIVE WARRANTY MADE BY SELLER TO BUYER AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED, IMPLIED, OR STATUTORY, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE.

The user assumes all responsibility and liability for proper and safe handling of the goods. Further, the user indemnifies TI from all claims arising from the handling or use of the goods. Please be aware that the products received may not be regulatory compliant or agency certified (FCC, UL, CE, etc.). Due to the open construction of the product, it is the user's responsibility to take any and all appropriate precautions with regard to electrostatic discharge.

EXCEPT TO THE EXTENT OF THE INDEMNITY SET FORTH ABOVE, NEITHER PARTY SHALL BE LIABLE TO THE OTHER FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES.

TI currently deals with a variety of customers for products, and therefore our arrangement with the user is **not exclusive**.

TI assumes **no liability for applications assistance, customer product design, software performance, or infringement of patents or services described herein**.

Please read the EVM User's Guide and, specifically, the EVM Warnings and Restrictions notice in the EVM User's Guide prior to handling the product. This notice contains important safety information about temperatures and voltages. For further safety concerns, please contact the TI application engineer.

Persons handling the product must have electronics training and observe good laboratory practice standards.

No license is granted under any patent right or other intellectual property right of TI covering or relating to any machine, process, or combination in which such TI products or services might be or are used.

Mailing Address:

Texas Instruments
Post Office Box 655303
Dallas, Texas 75265

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

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

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

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI 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 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. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation.

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

Mailing Address:

Texas Instruments
Post Office Box 655303
Dallas, Texas 75265