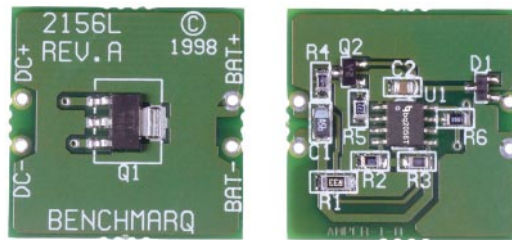


# Designed to GO . . .

Practical and Cost-Effective Battery Management Design Examples by Benchmarq  
Series 2056, Number One



## Single- and Double-Cell Low-Dropout Lithium-Ion Charger Using the bq2056



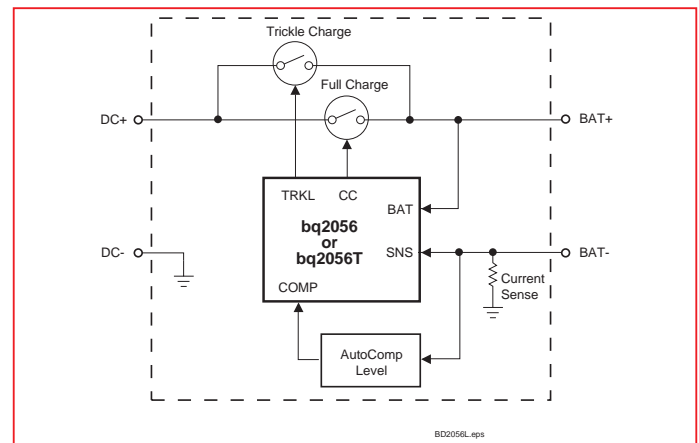
### Features

- ◆ Circuit board measures only 1.0 x 1.0 in (25 x 25 mm)
- ◆ Supports 1 or 2 Li-Ion cells and 300mA of charging current
- ◆ Dual-stage algorithm reduces charging time
- ◆ Pre-charge qualification by checking battery voltage
- ◆ Pre-charge conditioning for reviving deeply discharged batteries
- ◆ Optional AutoComp™ Charge-rate compensation for faster charge time
- ◆ Low drop-out linear design with low side current sensing
- ◆ Schematic, bill-of-materials and board layout available from Benchmarq for immediate implementation

### Typical Applications

- ◆ Low cost fast chargers for Cellular and handheld electronic equipment
- ◆ Low-Dropout chargers

### Functional Block Diagram



## bq2056 Designed to Go

### General Description

In this example the bq2056 is used to design a simple and cost-effective single or double-cell Li-Ion linear charger. This implementation is suitable for any application requiring a low-dropout fast charger in a small footprint.

This design takes advantage of various built-in features of the bq2056 to safely initiate and control high speed charging of single or double-cell Li-Ion packs:

**Circuit topology:** Low-dropout linear regulator with low-side current sensing

**Charge algorithm:** The bq2056 charges a battery in two stages. A constant-current stage replenishes approximately 70% of battery capacity. A voltage regulation stage completes the charge.

**Battery chemistry supported:** Lithium-Ion

**Maximum number of cells:** 1 with bq2056 and 2 with bq2056T

**Maximum charging current:** 300 mA

**Input requirements:**

No. of Cells	Part No.	Min. Input	Max. Input	Regulated Output
1	bq2056	5V <sub>DC</sub>	9V <sub>DC</sub>	4.1V <sub>DC</sub>
2	bq2056T	9V <sub>DC</sub>	13V <sub>DC</sub>	8.2V <sub>DC</sub>

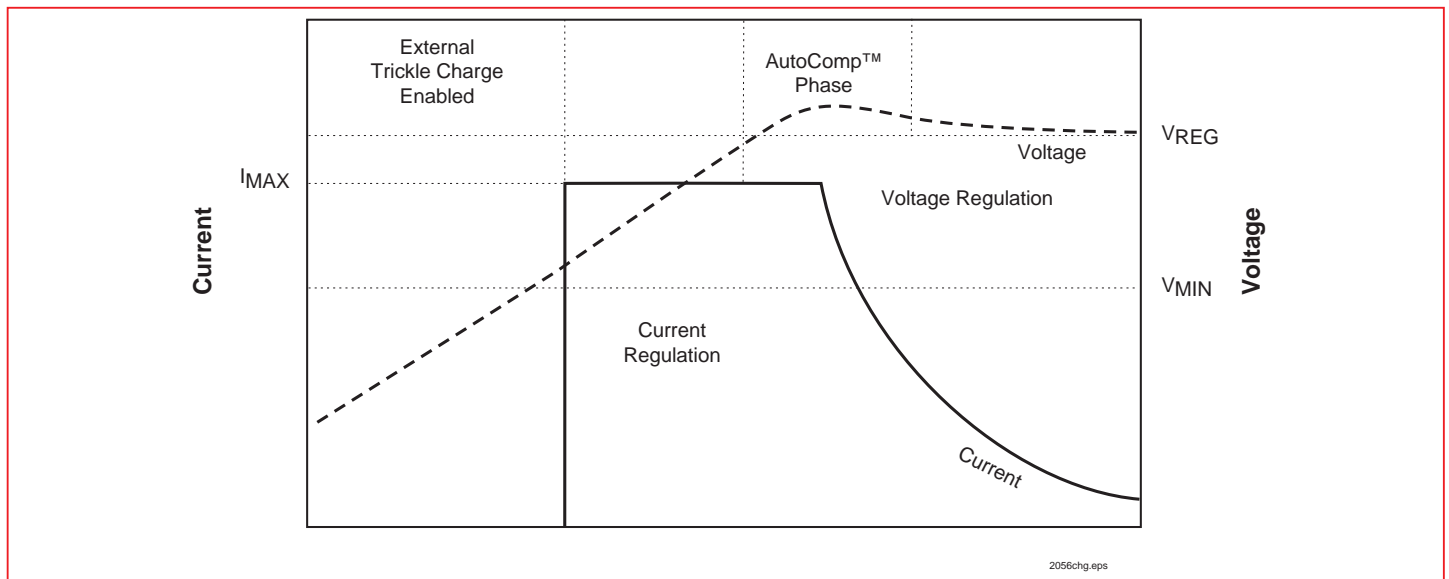
**Pre-charge qualification:** Battery voltage

Please refer to bq2056 Data Sheet for full specifications

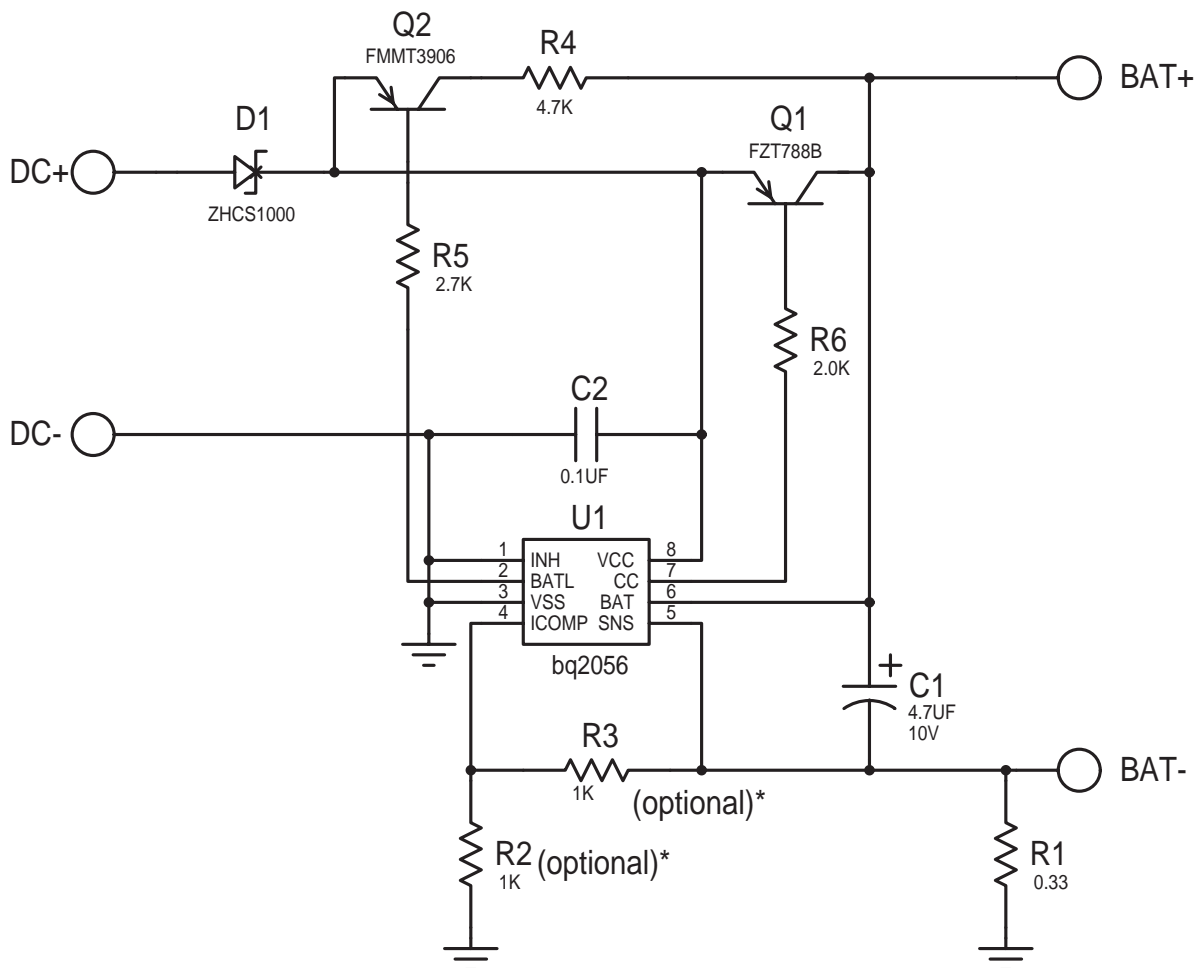
### Parts List

Item	Quantity	Reference	Part
1	1	C1	4.7nF, 10V
2	1	C2	0.1nF
3	1	D1	ZHCS1000 (Zetex)
4	1	Q2	FMMT3906
5	1	Q1	FZT788B (Zetex)
6	1	R2	
7	1	R3	
8	1	R4	4.7kΩ
9	1	R5	2.7kΩ
10	1	R6	2.0kΩ
11	1	R1	0.33Ω, 1%
12	1	U1	bq2056SN or bq2056TSN

### bq2056 Charge Algorithm



bq2056 Schematic



Designations:  
 DM2156H (single cell)  
 DM2156TH (two cell)

2156La.eps

\*Note: Pin 4 is connected to V<sub>SS</sub>.

## bq2056 Designed to Go

### Design Notes:

The following is intended to assist the designer in configuring the circuit. Please refer to the schematic for details.

#### Setting Voltage Regulation:

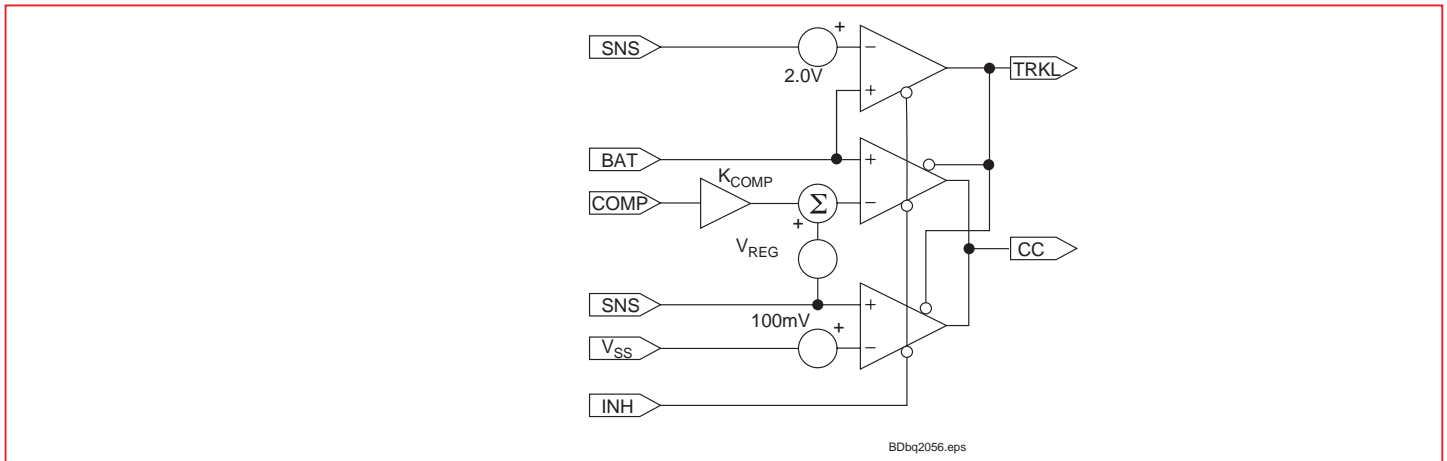
Voltage regulation level is set by the IC and no adjustments are required:

No. of Cells	Part No.	Min. Input	Max. Input	Regulated Output
1	bq2056	5V <sub>DC</sub>	9V <sub>DC</sub>	4.1V <sub>DC</sub>
2	bq2056T	9V <sub>DC</sub>	13V <sub>DC</sub>	8.2V <sub>DC</sub>

**Setting Current Regulation:** Maximum charging current can be set by the following equation:

$$I_{MAX} = \frac{0.1}{R_1}$$

### bq2056 Functional Block Diagram



## Dedicated Lithium-Ion battery management products from Benchmarq:

### Charge Management:

**bq2954:** The bq2954 simplifies charging of Li-Ion batteries by combining the necessary switch-mode power-supply support and charge-termination control into a single integrated circuit.

**bq2056/T/V:** These ICs are low-cost linear control devices ideal for designing simple and high accuracy charge management circuits. Featuring the new proprietary AutoComp™ technique for optimizing the charge algorithm, the bq2056 enables the battery to reach peak capacity in the shortest time without compromising safety or increasing the size of circuit components.

### Pack Supervisors:

**bq2058 and bq2058T:** Designed for battery pack integration, these ICs protect Li-Ion cells from excessive charge or discharge, and short circuits. These functions are critical for safety and longevity of the cells.

This circuit supports a maximum charging current of 300mA. Lower current can be set by changing the value of R6.

#### Setting AutoComp (optional):

In order to reduce charging time, the bq2056 series use proprietary AutoComp technique to safely compensate for internal impedance of battery during charge.

This is accomplished through input pin COMP. A portion of the current sense voltage, presented through this pin is scaled by a factor of  $K_{COMP}$  and summed with the regulation reference,  $V_{REG}$ . This has the effect of increasing the output voltage as output current increases.

In order to enable this option, the circuit can be easily modified by adding two external resistors. Please refer to the bq2056 data sheet for details.

### Gas Gauges:

**bq2040:** Designed for battery pack integration, the bq2040 IC monitors critical battery parameters such as remaining capacity, temperature, and voltage in rechargeable battery packs. It supports the System Management Bus (SMBus) and the Smart Battery Data (SBD) specifications and can interface with the host system and battery charger to form a comprehensive battery management system.

**bq2050:** This bq2050 Power-Gauge IC provides total solution for Li-Ion capacity monitoring by providing accurate information in mA hours and mW hours over a wide range of environmental and use conditions. The bq2050 compensates for temperature, charge and discharge rates and self-discharge and communicates with the host processor using a single-line bi-directional serial bus.



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