



## Fast Charge Development System

### Control of On-Board Linear Current Regulator or External Current Source

#### Features

- bq2003 fast-charge control evaluation and development
- Charge current sourced from an on-board linear regulator (1.25A, modifiable for 0.1 to 1.5 A) or an external current source
- Fast charge of 4 to 14 NiCd or NiMH cells
- Fast-charge termination by  $\Delta T/\Delta t$ ,  $-\Delta V$ , maximum temperature, time, and voltage
- $-\Delta V$  enable, hold-off, top-off, maximum time, number of cells, and off-board current source control are jumper-configurable
- Charging status displayed on charge and temperature LEDs
- Discharge-before-charge control with push-button switch
- Inhibit fast charge by external logic-level input

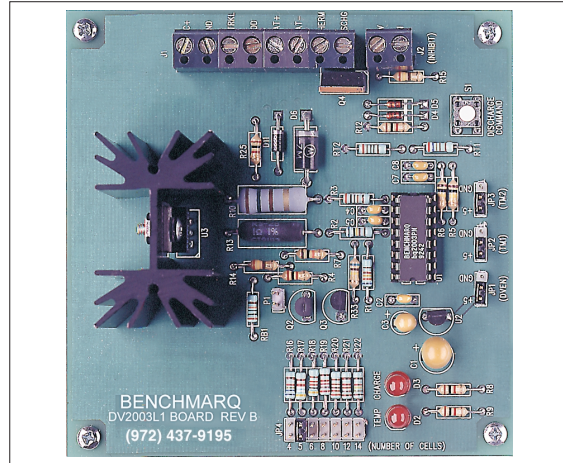
#### General Description

The DV2003L1 Development System provides a development environment for the bq2003 Fast-Charge IC. The DV2003L1 incorporates a bq2003 and an LM317 linear regulator to provide fast charge control for 4 to 14 NiCd or NiMH cells. The DV2003L1 also supports on/off control of an external current source.

The fast charge is terminated by any of the following:  $\Delta T/\Delta t$ ,  $-\Delta V$ , maximum temperature, maximum time, maximum voltage, or an external inhibit command.

Jumper settings select the  $-\Delta V$  enabled state, the hold-off, top-off, and maximum time limits, and enable the use of an external current source.

The user provides a power supply and batteries. If the on-board 1.25A linear regulator is disabled, the external current source must have an appropriate digitally controlled switch (active high). The user configures the DV2003L1 for the number of cells, charge termination, maximum charge time (with or without top-off), and commands the discharge-before-charge option with the push-button switch S1.



#### Connection Descriptions

J1	
DC+	DC input from charger supply
GND	Ground
XTRKL	Extra trickle input
MOD	bq2003 MOD pin connection for external control
BAT+	Positive battery terminal and high side of discharge load
BAT-	Negative battery terminal and thermistor connection
THERM	Thermistor connection
DSCHG	Low side of discharge load
J2	
+V	Voltage source for inhibit input
IN	Inhibit input to prevent bq2003 activity
JP1 DVEN	Negative voltage termination enable

# DV2003L1

JP2 TM1	TM1 setting
JP3 TM2	TM2 setting
JP4 NOC	Select number of cells
P1	External source control

## Fixed Configuration

The DV2003L1 board has the following fixed characteristics :

$V_{CC}$  (4.75–5.25V) is regulated on-board from the supply at connector J1 DC+.

LEDs indicate charge status and temperature fault status.

Pin CCMD is grounded, providing charge initiation on the later application of the battery or DC+, which provides  $V_{CC}$  to the bq2003.

Pin DCMD is pulled to ground through R12. A toggle of switch S1 momentarily pulls DCMD high and initiates a discharge-before-charge. The bq2003 DIS output activates FET Q4, allowing current to flow through an external current-limiting load between BAT+ and DSCHG on connector J1.

Trickle current is limited by a 150Ω/2W resistor R10 between DC+ and BAT+ (maximum potential across R10 = 17.3V). The trickle current may be increased by adding a parallel resistor from the DC+ source to XTRKL on connector J1. Note that too large a voltage between DC+ and BAT+ may exceed the wattage ratings of these resistors.

If enabled, the linear regulator U2 regulates up to 1.5A from the supply on connector J1 DC+ to the battery on BAT+. Because the LM317 current is set by R13 ( $I = 1.25/R13$ ), increasing this resistance provides regulation to a lower current. It is set to 1.25A (R13 = 1Ω).

When the linear regulator U2 is disabled, the output MOD on connector J1 is used to control an off-board current source connected to the positive battery terminal. Note that when an external source is used, the supply to connector J1 DC+ still provides both the board  $V_{CC}$  source and a trickle output at BAT+.

Charge current can be halted at any time via external stimulus. Connector J2 provides a +5V DC source (+V) and an inhibit input (IN) node for this function. To inhibit charge current, the J2 inhibit input (IN) is driven by +5V DC. To re-initiate charge, remove the voltage source from the inhibit input.

The maximum cell voltage (MCV) setting is 1.8V.

With the provided NTC thermistor connected between THERM and GND or BAT-, values are:  $LTF = 10^{\circ}C$ ,

$HTF = 44^{\circ}C$ , and  $TCO = 50^{\circ}C$ . The average  $\Delta T/\Delta t$  setting ( $T_{\Delta T}$ ) is  $1.04^{\circ}C/minute$ .

The thermistor is identified by the serial number suffix as follows:

Identifier	Thermistor
K1	Keystone RL0703-5744-103-S1
(blank)	Philips 2322-640-63103
F1	Fenwal Type 16, 197-103LA6-A01

## Jumper-Selectable Configuration

The DV2003L1 must be configured as described below.

**DVEN (JP1):** Enables/disables  $-\Delta V$  termination (see bq2003 data sheet).

**TM1 and TM2 (JP2 and JP3):** Select fast charge safety time/hold-off/top-off (see bq2003 data sheet).

Jumper Setting	Pin State
[ 1 2 ] 3	Enabled (high)
1 [ 2 3 ]	Disabled (low)

**Number of Cells (JP4):** A resistor-divider network is provided to select 4 to 14 cells (the resulting resistor value equals  $N - 1$  cells). RB1 is a 200KΩ resistor, and RB2 (R16–R22) is jumper-selected.

Jumper Setting	Pin State
[ 1 2 ] 3	High
1 [ 2 3 ]	Low
1 2 3	Float

Closed Jumper	Number of Cells
R22	14
R21	12
R20	10
R19	8
R18	6
R17	5
R16	4

**External Current Source Control (P1):** Enables/disables on-board linear regulator.

Jumper Setting	On-Board Regulator
[ 1 2 ]	Disabled
1 2	Enabled

**Temperature Disable:** Connecting a 10KΩ resistor between THERM and GND or BAT– disables temperature control.

## Setup Procedure

1. Configure DVEN, TM1, TM2, and number-of-cells (NOC) jumpers.
2. Connect the provided thermistor or a 10KΩ resistor across THERM to GND.

**Note:** RT1 and RT2 match the thermistor provided and must be changed if a different thermistor type

is used (see Appendix A in the application note, “Using the bq2003 to Control Fast Charge”).

- 3a. If using off-board regulation, close jumper P1 and attach the MOD connector to the external current control.
- 3b. If using on-board regulation, open jumper P1.
4. If using the discharge-before-charge option, connect a current-limiting discharge load from BAT+ to DSCHG.
5. If using the INHIBIT function, connect a switch across J2 (IN to +V) or connect INH to the controlling signal source (3–5V).
6. Attach the battery pack to BAT+ and BAT–. For temperature control, the thermistor must contact the cells.
7. Attach DC current source to DC+ (+) and GND (–) connections in J1.

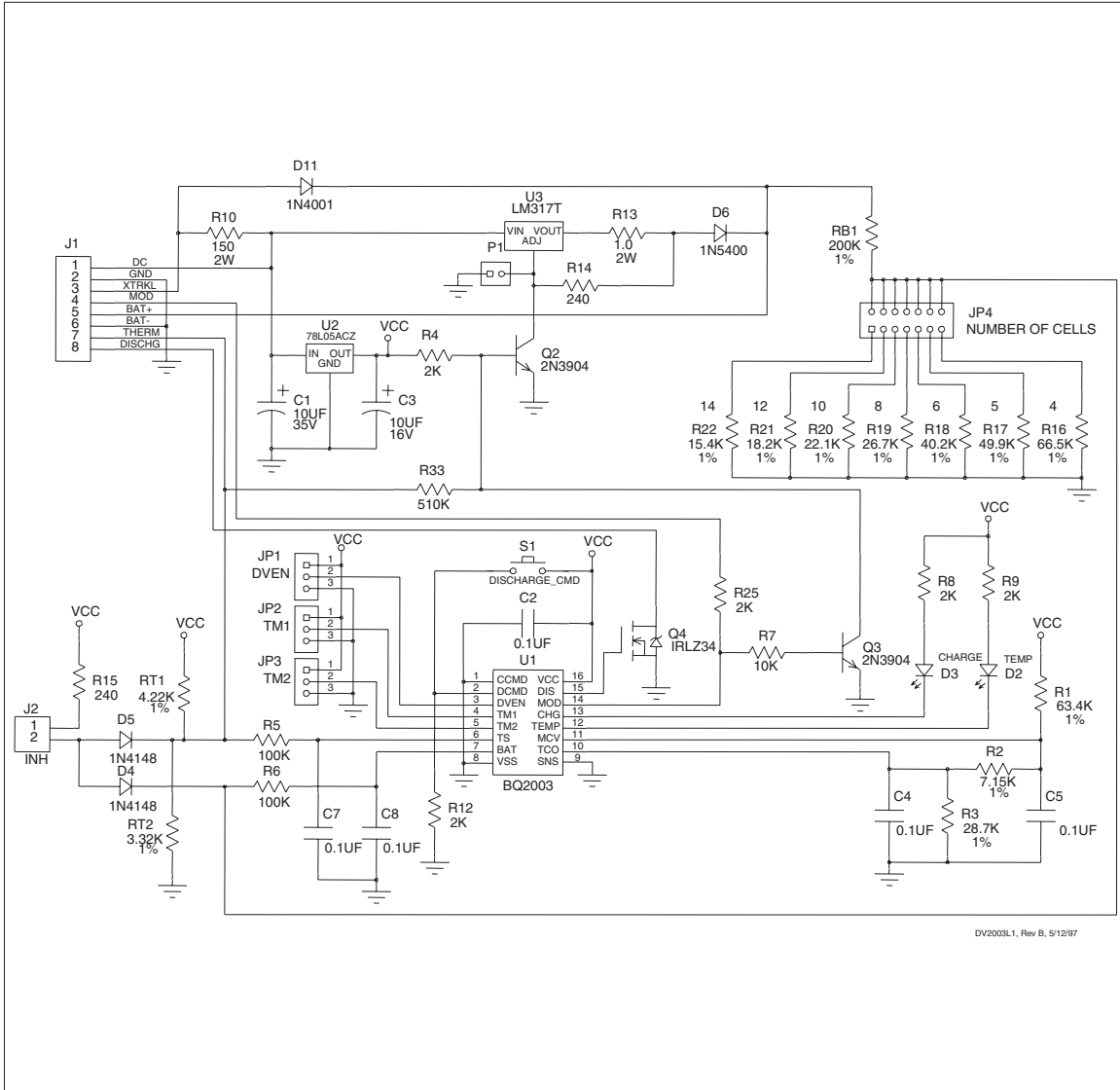
## Recommended DC Operating Conditions

Symbol	Description	Minimum	Typical	Maximum	Unit	Notes
I <sub>TRKL</sub>	External additional trickle current	-	-	1	A	
P <sub>D</sub>	LM317 power dissipation	-	-	6	W	$P_D = I_{DC+} * (V_{DC+} - V_{BAT+} - 2V)$
I <sub>DC+</sub>	LM317 input current	-	1.25	-	A	Configured rate.
	Maximum LM317 input current (with R13 = 0.83Ω, minimum value)	-	1.5	-	A	R13 changed for maximum rate.
V <sub>DC+</sub>	LM317 regulation enabled	$4.25 + V_{BAT+}$ or 10	-	$9.5 + V_{BAT+}$ or 35	V	Notes 1, 2
	External current source	10	-	$9.5 + V_{BAT+}$ or 35	V	
V <sub>BAT+</sub>	BAT+ input voltage	-	-	30	V	
V <sub>THERM</sub>	THERM input voltage	0	-	5	V	
V <sub>MOD</sub>	MOD output voltage	0	-	5	V	In series with R25
V <sub>IN</sub>	Inhibit input signal	0	-	5	V	
I <sub>DSCHG</sub>	Discharge load current	-	-	2	A	

- Note:**
1. The voltage drop across the LM317, diodes, and resistors in charge path—with the LM317 enabled—is approximately 4.25V. Maximum voltage drop across LM317 is primarily limited by the on-board heat sink and should be controlled to limit heat dissipation to 6W in free air. Additional cooling is necessary if the heat dissipation exceeds 6W.
  2. The input voltage must be greater than  $NOC * 1.8V + V_{LOSS}$  for detection of battery absent and for charge initiation on battery replacement.

# DV2003L1

## DV2003L1 Board Schematic



DV2003L1, Rev B, 5/12/97

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