DV2004ES3

Nickel/Li-Ion Development System

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

Features

- bq2004E fast charge control evaluation and development for NiMH, NiCd and Li-Ion chemistries
- Charge current sourced from an on-board switch-mode regulator (up to 2.0 A)
- Fast charge of 3, 6, or 9 NiCd or NiMH cells and 1, 2, or 3 Li-Ion cells
- Fast charge termination by delta temperature/delta time (ΔT/Δt), negative delta voltage (-ΔV) or peak voltage detect, maximum temperature, maximum time, and maximum voltage for nickel-based and constant-current to constant-voltage for Li-Ion
- -ΔV/peak voltage detect, hold-off, top-off, maximum time, and number of cells are jumper-configurable
- Programmable charge status display
- Discharge-before-charge control with push-button switch or auto discharge-before-charge with jumper
- Inhibit fast charge by logic-level input

General Description

The DV2004ES3 Development System provides a dual-chemistry development environment for the bq2004E Fast Charge IC. The DV2004ES3 incorporates a bq2004E and a buck-type switch-mode regulator to provide fast charge control for 3, 6, or 9 NiCd or NiMH cells and 1, 2, or 3 Li-Ion cells.

The fast charge is terminated by any of the following: ΔT/Δt, -ΔV or peak voltage detect, maximum temperature, maximum time, maximum voltage, and inhibit command. Jumper settings select the voltage termination mode, the hold-off, top-off, and maximum time limits, and automatic discharge-before-charge.

Fast charge for Li-Ion transitions from a constant-current to constant-voltage regulation. Voltage is regulated to within 1%. Charge complete is indicated at the maximum charge time.

The user provides a power supply and batteries. The user configures the DV2004ES3 for the number of cells and charge termination mode, and commands discharge-before-charge with push-button switch S1.

Please review the bq2004E data sheet and application note: "Using NiMH and Li-Ion Batteries in Portable Applications", before using the DV2004ES3 board.

Connection Descriptions

J1

SELC	Chemistry select
THERM	Thermistor connection
SNS	Negative battery terminal and thermistor connection
BAT+	Positive battery terminal and high side of discharge load
LOAD	Low side of discharge load
GND	Ground from charger supply
DC	DC input from charger supply

JP1 $\overline{INH}$	Inhibit input
JP2 DSEL	Display select
JP6 NOC	Select number of cells
JP7	Auto discharge-before-charge select
JP8	Auto cycle select

Fixed Configuration

The DV2004ES3 board has the following fixed characteristics:

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

LED1 and LED2 indicate charge status.

LED3 can replace LED1 and LED2 and provide an optional tri-color LED feature.

Charge initiates on the later application of the battery or DC, which provides V_{CC} to the bq2004E.

Pin $\overline{DCMD}$ may be tied to ground through JP7 for automatic discharge-before-charge. With JP7 open, a toggle of switch S1 momentarily pulls $\overline{DCMD}$ low and initiates a discharge-before-charge. The bq2004E output activates FET Q1, allowing current to flow through an external current-limiting load between BAT+ and LOAD on connector J1.

As shipped from Benchmarq, the DV2004ES3 buck-type switch-mode regulator is configured to a charging current of 1.5A. This current level is controlled by the value of sense resistor R_{SNS} by the relationship:

$$I_{CHG} = \frac{0.225V}{R_{SNS}}$$

The inductor is configured for a maximum of 1.5 Amp and should not be adjusted without consulting Benchmarq.

Zener diode D5 is used to limit Q4 V_{GS} per a given DC voltage. The board is shipped with D5 shorted. The user can modify this Zener diode for the application. Refer to Table 1 for suggested D5 values for DC voltages.

With the provided NTC thermistor connected between THERM and SNS, values are: LTF = 0°C, HTF = 40°C, and TCO = 60°C. The $\Delta T/\Delta t$ settings at 30°C ($T_{\Delta T}$) are: minimum = 0.82°C/minute, typical = 1.10°C/minute.

Table 1. Lookup Table for D5 Selection

+VDC Input (Volts)	Motorola Part No.	Nominal Zener Voltage
Below 15	Shorted	0
15–18	1N749	4.3
18–21	1N755	7.5
21–24	1N758	10
24–27	1N964A	13
27–30	1N966A	16
30–32	1N967A	18
32–35	1N968A	20

Note: Capacitors C2 and C3 must be changed from those shipped with the board for input voltage in excess of 24V.

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
O1	Ozhumi 150-108-00(4)
S1	Semetic 103AT-2

Jumper-Selectable Configuration

The DV2004ES3 must be configured as described below.

$\overline{INH}$ (JP1): Enables/disables charge inhibit (see bq2004E data sheet).

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

Number of Cells (JP6): A resistor-divider network is provided to select 3, 6, or 9 cells (the resulting resistor value equals $^{N}/_{2}$ – 1 cells).

Closed Jumper	Number of Cells	
	NiCd/NiMH	Li-Ion
RB22	9	3
RB21	6	2
RB20	3	1

Temperature Disable: Connecting a 10KΩ resistor between THERM and SNS disables temperature control.

DSEL (JP2): Selects LED1 and LED2 (LED3 optional) display state (see bq2004E data sheet, Table 2, page 5).

VSEL (JP3): Selects -ΔV or peak-voltage detection, or disables voltage-based termination (see bq2004E data sheet, page 7).

AUTO DIS SELECT (JP7): Jumping JP7 enables automatic discharge-before-charge.

AUTO CYCLE SELECT (JP8): Jumping JP8 automatically initiates a continuous discharge-before-charge / fast-charge cycling for data collection purposes.

Setup Procedure

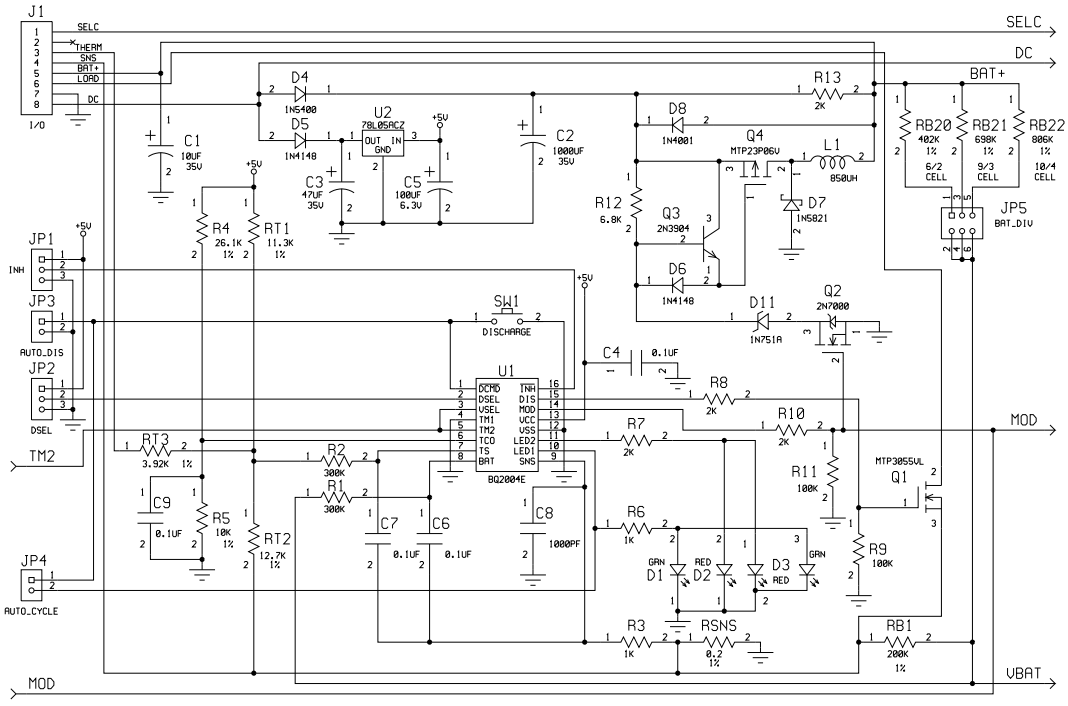
1. Configure TM1, TM2, DSEL, $\overline{INH}$, and number-of-cells (NOC) jumpers.
2. Connect the provided thermistor or a 10KΩ resistor between THERM and SNS.
3. If using the discharge-before-charge or auto-cycle options, connect a current-limiting discharge load between BAT+ and LOAD.
4. For nickel-based battery, attach the battery pack to BAT+, SNS, and THERM. SELC should float. For Li-Ion, SELC must be connected to BAT+ to operate properly.
5. Attach DC current source to DC (+) and GND (–) connections in J1.

Recommended DC Operating Conditions

Symbol	Description	Minimum	Typical	Maximum	Unit	Notes
I_{DC}	Maximum input current	-	-	1.5	A	
V_{DC}	Maximum input voltage	2.0 + V_{BAT} or 15	-	18 + V_{BAT} or 35	V	Note 1
V_{BAT}	BAT input voltage	-	-	24	V	
V_{THERM}	THERM input voltage	0	-	5	V	
I_{DSCHG}	Discharge load current	-	-	2	A	

Note: 1. The V_{DC+} limits consider the appropriate Zener diode at D5. The voltage at D5 is application-specific and limits the V_{GS} of Q4 to a safe enhancement value during Q4 conduction. See Table 1 for recommended D5 selections per V_{DC+}.

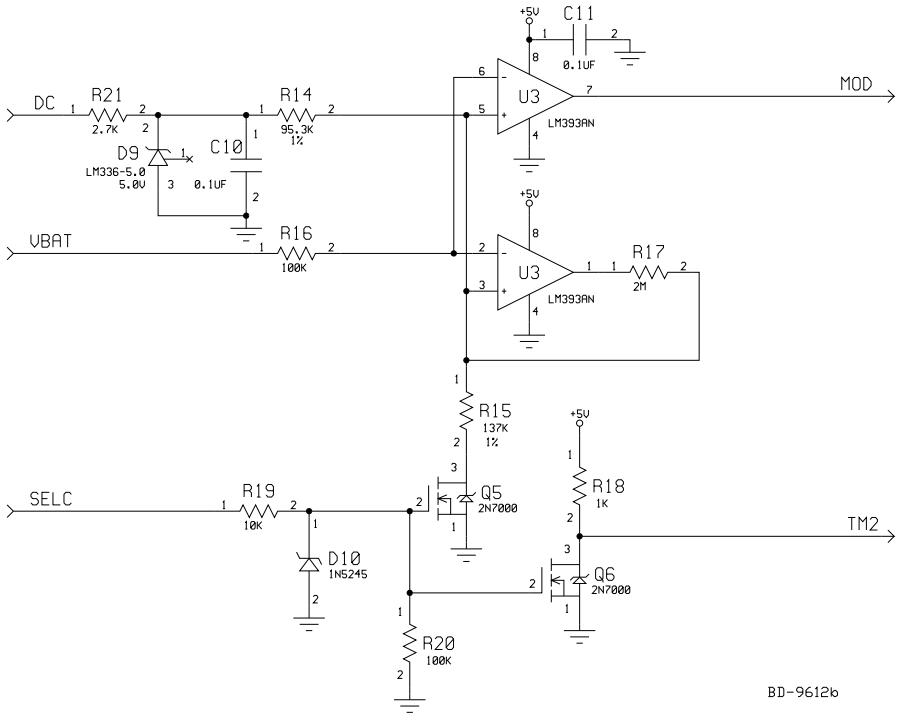
DV2004ES3 Board Schematic



1. USE SEMETEC 103AT THERMISTOR.

BD-9612

DV2004ES3 Board Schematic Continued



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