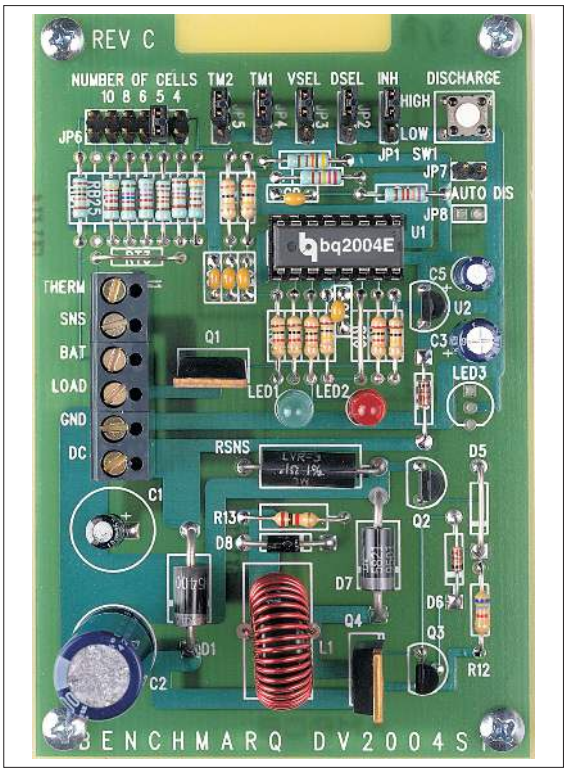
# DV2004S1/ES1/HS1

## Fast-Charge Development System

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




## Features

- bq2004/E/H fast charge control evaluation and development
- Charge current sourced from an on-board switch-mode regulator (up to 3.0 A)
- Fast charge of 4 to 10 NiCd or NiMH cells and one user-defined selection
- Fast charge termination by delta temperature/delta time ($\Delta T/\Delta t$), negative delta voltage ($-\Delta V$) or peak voltage detect, maximum temperature, maximum time, and maximum voltage
- $-\Delta V$/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 DV2004S1/ES1/HS1 Development System provides a development environment for the bq2004/E/H Fast Charge IC. The DV2004S1/ES1/HS1 incorporates a bq2004/E/H and a buck-type switch-mode regulator to provide fast charge control for 4 to 10 NiCd or NiMH cells.

The fast charge is terminated by any of the following: $\Delta T/\Delta t$, $-\Delta V$ 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.

The user provides a power supply and batteries. The user configures the DV2004S1/ES1/HS1 for the number of cells, voltage, charge termination mode, and maximum charge time (with or without top-off), and commands discharge-before-charge with push-button switch S1.

Please review the bq2004/E/H data sheet before using the DV2004S1/ES1/HS1 board.

## Connection Descriptions

J1

| | |
|---|---|
| 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 |
| JP3 | VSEL | Voltage termination select |
| JP4 | TM1 | TM1 setting |
| JP5 | TM2 | TM2 setting |
| JP6 | NOC | Select number of cells |
| JP7 | | Auto discharge-before-charge select |
| JP8 | | Auto cycle select |

# Fixed Configuration

The DV2004S1/ES1/HS1 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 bq2004/E/H.

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 DV2004S1/ES1/HS1 buck-type switch-mode regulator is configured to a charging current of 2.25A. This current level is controlled by the value of sense resistor $R_{SNS}$ by the relationship:

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

The value of $R_{SNS}$ at shipment is 0.100Ω. This resistor can be changed depending on the application.

The suggested maximum $I_{CHG}$ for the DV2004S1/ES1/HS1 board is 3A. The maximum cell voltage (MCV) setting is 1.8V.

**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.

**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.

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.

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 DV2004S1/ES1/HS1 must be configured as described below.

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

**$\overline{INH}$ (JP1)**: Enables/disables charge inhibit (see bq2004/E/H data sheet).

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

**TM1 and TM2 (JP4 and JP5)**: Select fast charge safety time/hold-off/top-off (see bq2004/E/H data sheet).

**Number of Cells (JP6)**: A resistor-divider network is

| Closed Jumper | Number of Cells |
|---|---|
| RB25 | User-selectable |
| RB24 | 10 |
| RB23 | 8 |
| RB22 | 6 |
| RB21 | 5 |
| RB20 | 4 |

provided to select 4 to 10 cells (the resulting resistor value equals $^{N}/_{2}$ – 1 cells). RB1 is a 150KΩ resistor, and RB2 (RB20–RB25) is jumper-selected.

**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 ssheet, 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 VSEL, TM1, TM2, DSEL, $\overline{\text{INH}}$, 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. Attach the battery pack to BAT+ and SNS. For temperature control, the thermistor must contact the cells.
5. Attach DC current source to DC (+) and GND (–) connections in J1.

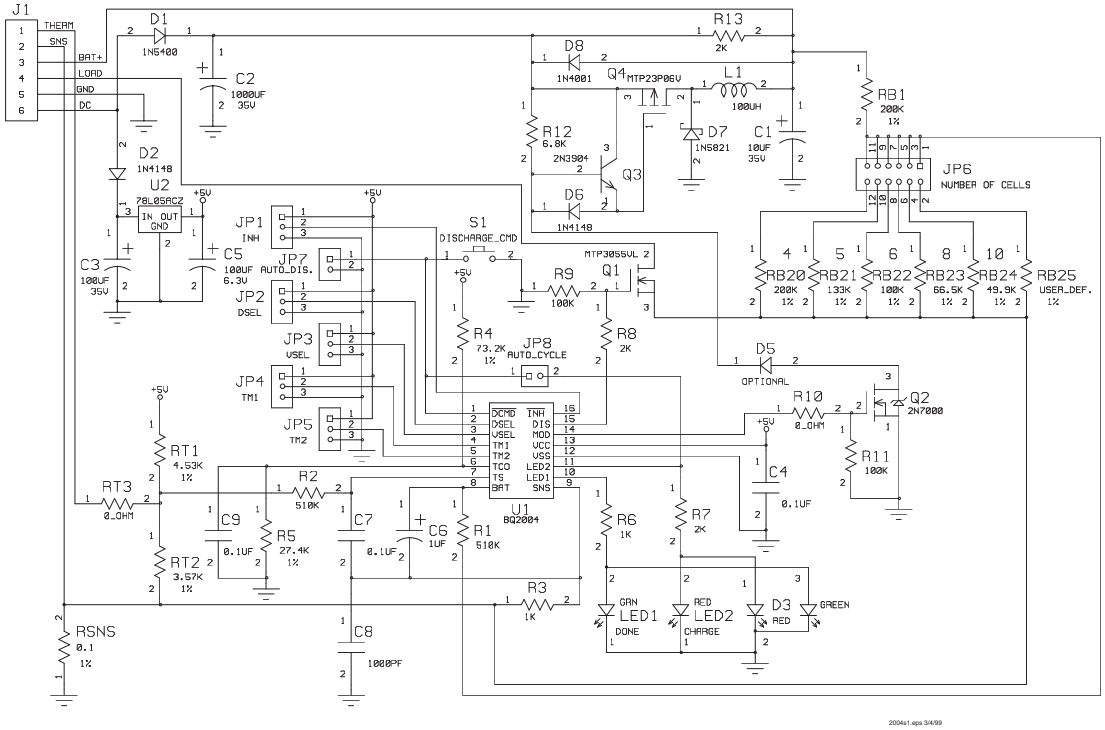
## Recommended DC Operating Conditions

| Symbol | Description | Minimum | Typical | Maximum | Unit | Notes |
|---|---|---|---|---|---|---|
| $I_{DC}$ | Maximum input current | - | - | 2.4 | 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 $V_{DC+}$.

Rev. C Board

# DV2004S1




Rev. C Board

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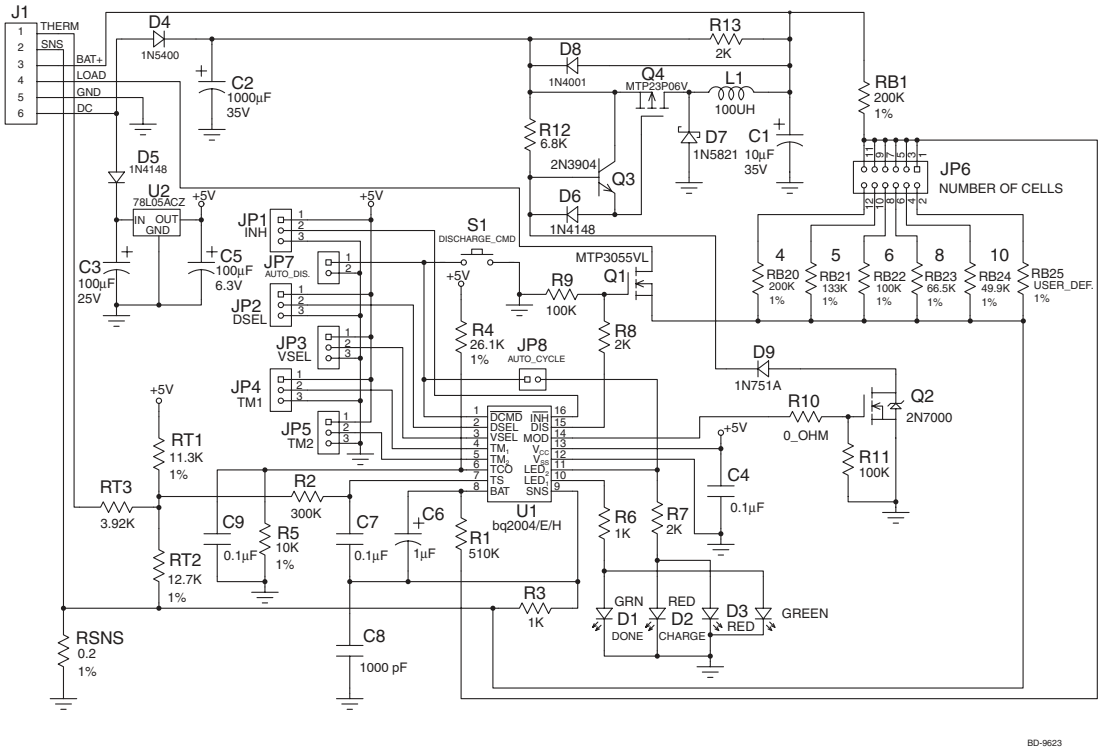


1. Use semetec 103AT thermistor.

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