

# MAXIM

## MAX1737 Evaluation Kit

### General Description

The MAX1737 evaluation kit (EV kit) is an assembled and tested PC board that implements a step-down, switching lithium-ion (Li+) battery charger. It can be set to charge 1 to 4 series cells. The cell voltage can be set between 4.0V and 4.4V, using standard 1% resistors, while maintaining 1% overall regulation accuracy.

The MAX1737 detects faulty cells and terminates charging. Two capacitors are used to set the charge termination, prequalification, and fault timeout periods. Three LEDs indicate the charging status. A user-supplied thermistor can be connected to the MAX1737 EV kit to monitor battery temperature and suspend charging for over- and undertemperature conditions.

### Features

- ◆ Complete Li+ Charging Solution for 1 to 4 Cells
- ◆ Low Heat and High Efficiency
- ◆ 300kHz PWM Operation
- ◆ Up to 28V Input Voltage Range
- ◆ 28-Pin QSOP Package
- ◆ Surface-Mount Construction
- ◆ Fully Assembled and Tested

### Ordering Information

| PART         | TEMP. RANGE  | IC PACKAGE |
|--------------|--------------|------------|
| MAX1737EVKIT | 0°C to +70°C | 28 QSOP    |

### Component List

| DESIGNATION                  | QTY | DESCRIPTION   |
|------------------------------|-----|---|
| C1                           | 1   | 4.7 $\mu$ F, 10V X5R ceramic capacitor<br>Taiyo Yuden<br>LMK316BJ475ML or<br>Murata GRM42-6X5R475K10  |
| C2, C4, C7, C10, C11         | 5   | 0.1 $\mu$ F, 50V X7R ceramic capacitors (0805)<br>Murata GRM40034X7R104K050 or<br>Taiyo Yuden<br>UMK212BJ104KG                              |
| C3                           | 1   | 0.22 $\mu$ F, 50V X7R ceramic capacitor<br>Taiyo Yuden<br>UMK316BJ224ML   |
| C5, C6                       | 2   | 0.047 $\mu$ F, 50V X7R ceramic capacitors   |
| C8, C9                       | 2   | 0.1 $\mu$ F, 50V X7R ceramic capacitors (1206)  |
| C12, C13, C14, C21, C22, C23 | 6   | 1000pF, 50V X7R ceramic capacitors  |
| C15                          | 1   | 68 $\mu$ F, 20V, 0.150 $\Omega$ , low-ESR tantalum capacitor<br>AVX TPSE686M020R0150  |
| C18, C19                     | 2   | 22 $\mu$ F, 35V, 0.300 $\Omega$ , low-ESR tantalum capacitors<br>AVX TPSE226M035R0300 or<br>Kemet T495X226M035AS                            |
| D1, D4                       | 2   | Schottky diodes, 3A, 40V<br>Fairchild MBRS340,<br>General Semiconductor SS34,<br>Motorola MBRS340, or<br>Vishay Liteon/Diodes, Inc.<br>B340 |

| DESIGNATION        | QTY | DESCRIPTION  |
|--------------------|-----|--|
| D2, D3             | 2   | Diodes 1N4148-type<br>Fairchild MMSD4148,<br>General Semiconductor<br>1N4148W, or Vishay Liteon/<br>Diodes, Inc. 1N4148W |
| JU1, JU3, JU4      | 5   | 2-pin headers  |
| JU2, JU5           | 2   | 3-pin headers  |
| JU6                | 1   | 4-pin header   |
| JU7, JU8           | 0   | Not installed  |
| L1                 | 1   | 22 $\mu$ H, 2.8A inductor<br>Sumida CDRH124-220  |
| LED1, LED2         | 2   | Light-emitting diodes (green)  |
| LED3               | 1   | Light-emitting diode (red)   |
| N1 (N1A, N1B)      | 1   | Dual N-channel MOSFET<br>Fairchild FDS6990A  |
| R1, R11            | 2   | 10k $\Omega$ $\pm$ 5% resistors  |
| R2, R3, R4         | 3   | 1k $\Omega$ $\pm$ 5% resistors   |
| R5–R10             | 6   | 100k $\Omega$ $\pm$ 1% resistors   |
| R12                | 1   | 0.05 $\Omega$ $\pm$ 1%, 0.5W sense resistor<br>Dale-Vishay WSL-2010-R050F<br>or<br>IRC LRC-LR2010-01-R050-F              |
| R13, R14, R19, R20 | 4   | 4.7 $\Omega$ $\pm$ 5% resistors  |
| R15, R17           | 0   | Not installed  |
| R18                | 1   | 0.1 $\Omega$ $\pm$ 1%, 0.5W sense resistor<br>Dale-Vishay WSL-2512-R100F<br>or<br>IRC LRC-LR2512-01-R100-F               |
| U1                 | 1   | MAX1737EEI   |
| None               | 5   | Shunts   |

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## Quick Start

The MAX1737 EV kit is a fully assembled and tested surface-mount board. Follow the steps below to verify board operation. **Do not turn on the power supply until all connections are completed. Observe all precautions on the battery manufacturer's data sheet. Use only lithium-ion cells with this charger:**

- 1) Set jumper JU6 to indicate the number of cells in the battery pack (Table 1).
- 2) Place a shunt on jumper JU1 to disable the temperature monitoring function.
- 3) Place a shunt across pins 1-2 on JU2 to enable the MAX1737.
- 4) Place a shunt across JU3 to enable 2A charging current limit.
- 5) Place a shunt across JU4 to enable 2A input current limit.
- 6) Remove any shunt from JU5 to set the cell voltage to 4.2V. If a different battery regulation voltage is required, refer to the MAX1737 data sheet.
- 7) Connect a +7VDC to +28VDC power supply with sufficient power rating across the VIN and GND pads.
- 8) Connect a lithium-ion battery pack between the BATT+ and BATT- pads.
- 9) Turn on the power supply.
- 10) Measure the battery voltage and verify that the LEDs indicate the correct state.

## Detailed Description

When battery charging is initiated, the charger enters the prequalification state. In this state, the batteries are charged at 1/20 of the programmed current limit while the charger measures the battery to determine if it can be charged. If the battery voltage is above 2.5V per cell, charging begins. At this time, the batteries are charged at a constant current (Fast Charge state) and a constant voltage (Full Charge state). The charger exits the Full Charge state and enters the Top Off state once the battery current drops to 10% of the Fast Charge current, or the Fast Charge timer expires. The charger remains in the Top Off state for 45 minutes, at which time charging is terminated.

Once charging is terminated, if the battery voltage drops 5% from the fully charged voltage, charging automatically restarts.

If, at any time during charging, the thermistor input senses a temperature below 0°C or above +50°C, charging suspends until the temperature returns to a safe level. If the charger is unable to enter the Fast Charge or Full Charge state, charging is terminated and the Fault LED

(red) lights indicate a faulty battery. This kit is shipped with a 10kΩ resistor to disable the temperature monitoring function. If temperature monitoring is required, connect the appropriate thermistor (see *Jumper Selection* section).

For more information on the operation of the MAX1737, refer to the *Detailed Description* section of the MAX1737 data sheet.

## Charging Status

The three LEDs on the EV kit indicate the charging status:

- LED1 (FULLCHG) indicates that the battery pack is being charged with a constant voltage.
- LED2 (FASTCHG) indicates that the battery pack is being charged with a constant current.
- LED3 (FAULT) indicates that charging terminated abnormally.

## Jumper Selection

Jumper JU1 connects the MAX1737 thermistor input (THERM) to GND through a 10kΩ resistor, disabling temperature qualification. To enable temperature qualification (charging between 0°C and 50°C), remove the shunt from JU1, and connect a thermistor (BC Components part number 2322-640-63103 or equivalent) to the THERM and GND pads. For more information, refer to the MAX1737 data sheet.

The MAX1737 can be placed in shutdown mode using jumper JU2. See Table 1 for jumper settings.

Jumper JU3 sets the charging current limit (current to the battery). A shunt across this jumper limits the output current to 2A. With the shunt removed, a resistor-divider formed by R5 and R6 sets the current. The EV kit comes with the resistors selected for a 1A current limit. A different current can be selected by changing the resistors (refer to the MAX1737 data sheet).

Jumper JU4 sets the input current limit (current from the power supply). A shunt across this jumper limits the input current to 2A. With the shunt removed, a resistor-divider formed by R7 and R8 sets the current. The EV kit comes with the resistors selected for a 1A current limit. A different current can be selected by changing the resistors (refer to the MAX1737 data sheet).

Jumper JU5 sets the voltage per cell. Jumper JU6 selects the number of series cells to be charged. See Table 1 for jumper settings.

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**Table 1. Jumper Selection**

| JUMPER | JUMPER POSITION | FUNCTION   |
|--------|-----------------|--|
| JU1    | Open            | Open before connecting a thermistor from THERM to GND pads.                  |
|        | Closed*         | Bypasses THERM with 10kΩ resistor.   |
| JU2    | 1-2*            | SHDN = high. MAX1737 enabled.  |
|        | 2-3             | SHDN = low. MAX1737 disabled.  |
|        | Open            | Drive SHDN pad with an external signal.                                      |
| JU3    | Open            | ISETOUT = REF/2. Charging current limited to 1A.                             |
|        | Closed*         | ISETOUT = REF. Charging current limited to 2A.                               |
| JU4    | Open            | ISETIN = REF/2. Input current limited to 1A.                                 |
|        | Closed*         | ISETIN = REF. Input current limited to 2A.                                   |
| JU5    | 1-2             | VADJ = REF. Voltage per cell = 4.4V.   |
|        | 2-3             | VADJ = GND. Voltage per cell = 4.0V.   |
|        | Open*           | VADJ = REF/2. Voltage per cell = 4.2V. Set by resistor-dividers R9 and R10.† |
| JU6    | 1-2*            | CELL = GND. Cell count = 1.  |
|        | 1-3             | CELL = VL. Cell count = 4.   |
|        | 1-4             | CELL = REF. Cell count = 3.  |
|        | Open            | CELL = Float. Cell count = 2.  |

\*Default position

†For other voltages, refer to the Setting the Battery Regulation Voltage section of the MAX1737 data sheet.

## Component Suppliers

| SUPPLIER                          | PHONE        | FAX          |
|-----------------------------------|--------------|--------------|
| AVX                               | 803-946-0690 | 803-626-3123 |
| BC Components                     | 803-772-2500 |              |
| Dale-Vishay                       | 402-564-3131 | 402-563-6418 |
| Fairchild                         | 408-822-2000 | 408-822-2102 |
| General Semiconductor             | 631-847-3000 | 631-847-3236 |
| International Resistive Co. (IRC) | 310-322-3331 | 310-322-3332 |
| Kemet                             | 408-986-0424 | 408-986-1442 |
| Motorola                          | 303-675-2140 | 303-675-2150 |
| Murata                            | 814-237-1431 | 814-238-0490 |
| Sumida                            | 847-956-0666 | 847-956-0702 |
| Taiyo Yuden                       | 408-573-4150 | 408-573-4159 |
| Vishay Liteon/Diodes, Inc.        | 805-446-4800 | 805-446-4850 |

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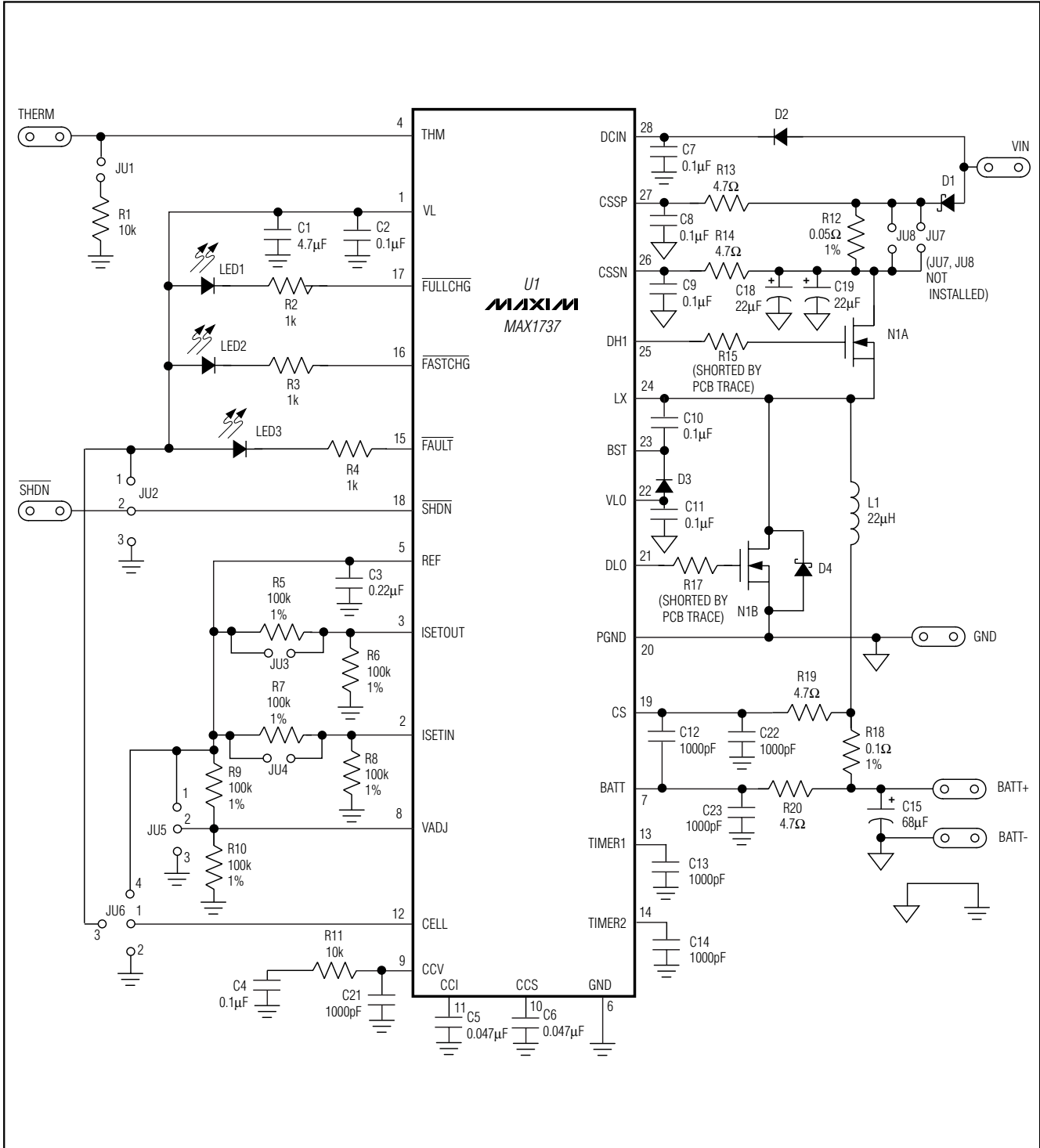


Figure 1. MAX1737 EV Kit Schematic

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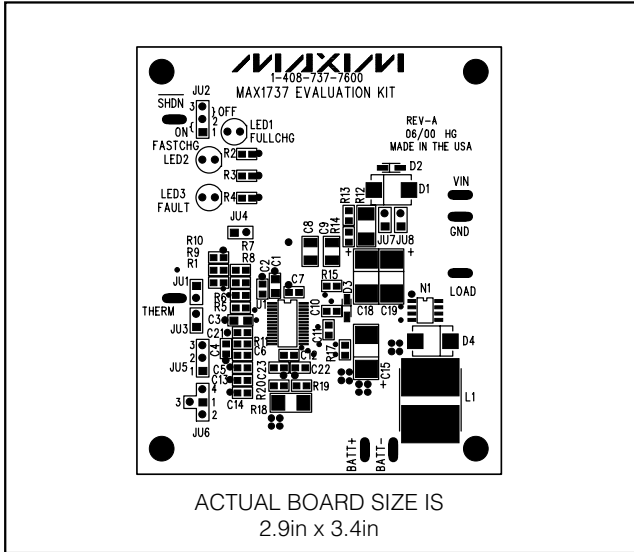


Figure 2. MAX1737 EV Kit Component Placement Guide—Component Side

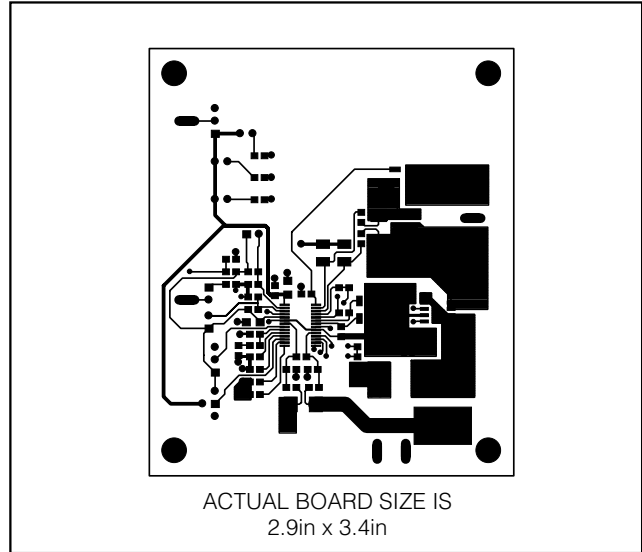


Figure 3. MAX1737 EV Kit PC Board Layout—Component Side

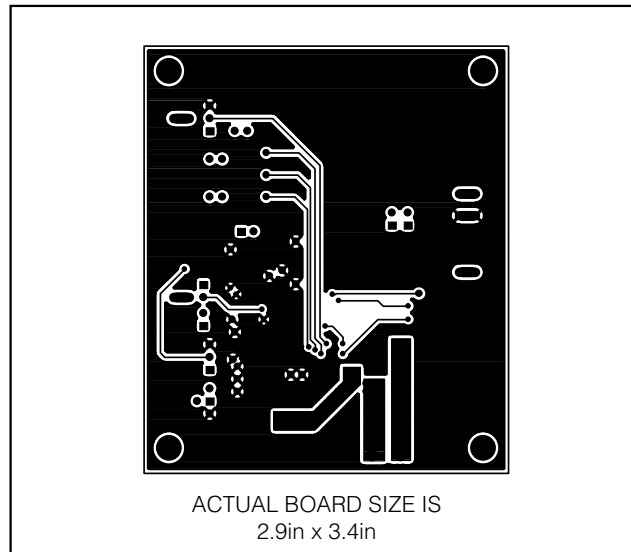


Figure 4. MAX1737 EV Kit PC Board Layout—Solder Side

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