

Using the High-Input-Voltage Travel Charger for Single Cell Li-Ion Batteries (KIT34674EPEVBE)

1 Purpose

This User Guide helps the Li-Ion battery travel charger designer to understand the MC34674 and its evaluation board. It illustrates the design procedure when using MC34674 to design a Li-Ion battery charger and the way to get the best performance of the MC34674.

2 Scope

The MC34674 is a high input voltage single-cell Li-Ion battery charger optimized for travel charger application. Only a dual-color LED indicator, a thermistor, and two de-couple capacitors are required to design the travel charger. It also features $\pm 0.4\%$ output voltage accuracy and $\pm 8\%$ charge current accuracy over-temperature range. Its high input voltage of 28V allows low cost AC/DC adapter to be used to save the total cost. The charge current is preset by the factory from 50mA through 1050mA. The end of charge (EOC) current is preset to 10% of the CC-mode charge current by the factory. When the battery voltage is below the

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Application Diagram

trickle charge threshold of 2.9V, the MC34674 charges the battery with 10% of the CC-mode charge current. The dual-color LED indicates the first power up, charging, charge completed, battery disconnected and fault status. Its internal thermal foldback control reduces the charge current automatically whenever the die temperature reaches the thermal limit threshold of 110°C, to keep the charger safe. When there is no input power or when the MC34674 is disabled, the charger draws less than 1.0µA leakage current from the battery.

3 Application Diagram

The typical travel charger with MC34674 is shown in **Figure 1**. Generally the DC input is from an AC/DC adapter.

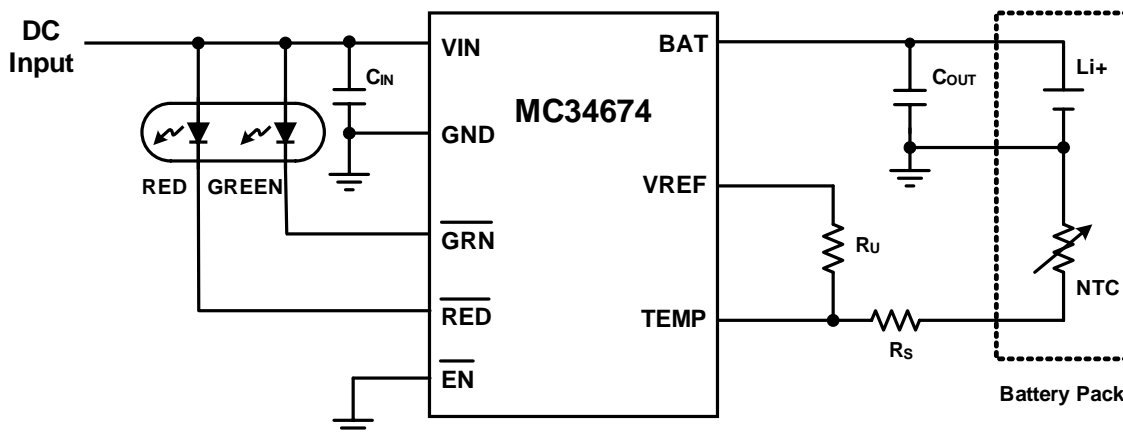


Figure 1. Typical Travel Charger

4 Evaluation Board Specification

The evaluation board is designed to work as a travel charger. **Figure 2** shows its schematic circuit. **Table 1** is the BOM list of the evaluation board. The normal operation range of the evaluation board is shown by the following:

$$V_{IN_MIN}=4.3V, V_{IN_MAX}=11V$$

$$I_{CHG}=650mA$$

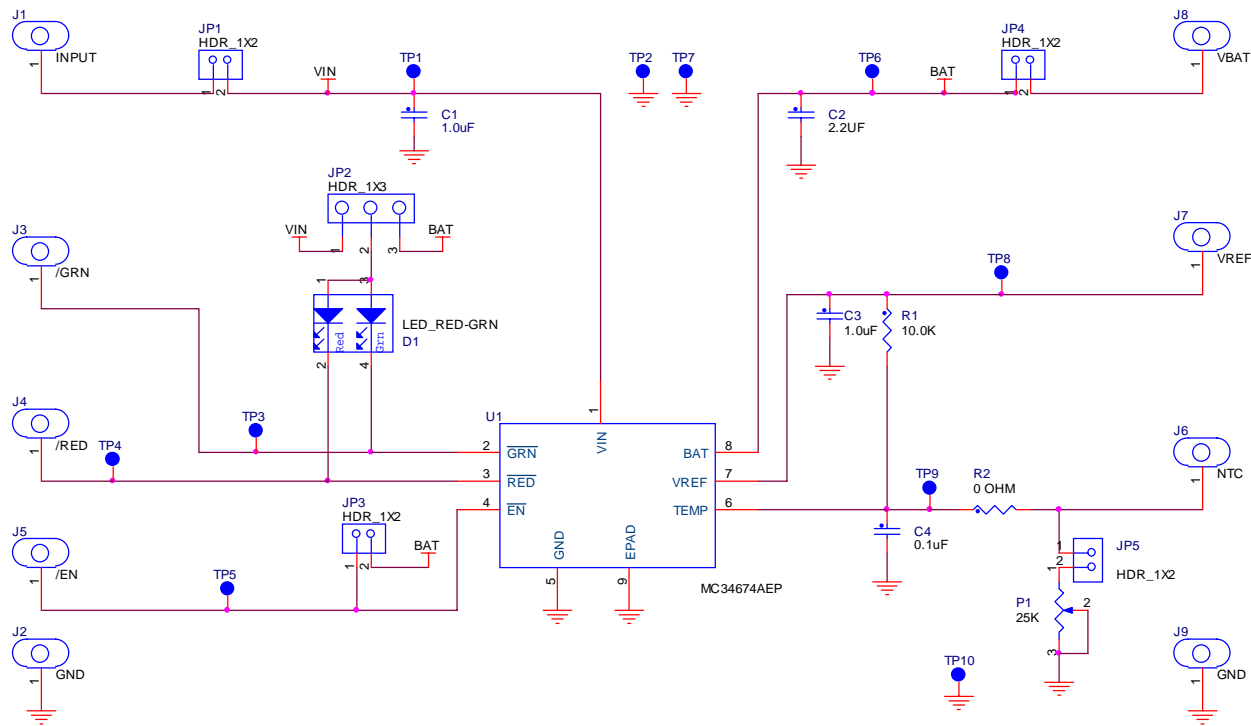


Figure 2. Schematic Circuit

Table 1. Evaluation Board Components

| Designator | Footprint | Part Value | Part Number | Description | Vendor |
|------------|--------------------|------------|-----------------|------------------------|------------|
| C1 | CC0603 | 1.0μF | C1608X5R1C105K | 16V, X5R ceramic, 10% | TDK |
| C2 | CC0603 | 2.2μF | C1608X5R1C225K | 16V, X5R ceramic, 10% | TDK |
| C3 | CC0603 | 1.0μF | C1608X5R1C225K | 16V, X5R ceramic, 10% | TDK |
| C4 | CC0603 | 0.1μF | C1608X5R0J104K | 6.3V, X5R ceramic, 10% | TDK |
| R1 | RC0603 | 10K | RK73H1JTTD1002F | MF, 1%, 1/10W | KOA SPEER |
| R2 | RC0603 | 0 Ohm | CR-03JL7-0R | MF, 1%, 1/10W | VENKEL |
| P1 | POT3_3296Y | 25K | 3296Y-1-253LF | 25 Turns, 10%, 1/2W | BOURNS |
| D1 | LED_DUAL_3025mm_SM | RED-GREEN | APB3025ESFC-F01 | RED/GRN dual color LED | KINGBRIGHT |
| TP1 | TP | VIN | TP-105-01-00 | Test Point | COMPONENTS |
| TP2 | TP | GND | TP-105-01-00 | Test Point | COMPONENTS |
| TP3 | TP | GRN | TP-105-01-00 | Test Point | COMPONENTS |
| TP4 | TP | RED | TP-105-01-00 | Test Point | COMPONENTS |
| TP5 | TP | EN | TP-105-01-00 | Test Point | COMPONENTS |
| TP6 | TP | BAT | TP-105-01-00 | Test Point | COMPONENTS |
| TP7 | TP | GND | TP-105-01-00 | Test Point | COMPONENTS |
| TP8 | TP | VREF | TP-105-01-00 | Test Point | COMPONENTS |
| TP9 | TP | TEMP | TP-105-01-00 | Test Point | COMPONENTS |
| TP10 | TP | GND | TP-105-01-00 | Test Point | COMPONENTS |
| JP1 | HDR102 | 2-PIN | 826629-2 | TH 100MIL SP 375H | TYCO |
| JP2 | HDR103 | 3-PIN | 826629-3 | TH 100MIL SP 375H | TYCO |

Table 1. Evaluation Board Components

| Designator | Footprint | Part Value | Part Number | Description | Vendor |
|------------|------------|------------|-------------|--|-----------|
| JP3 | HDR102 | 2-PIN | 826629-2 | TH 100MIL SP 375H | TYCO |
| JP4 | HDR102 | 2-PIN | 826629-2 | TH 100MIL SP 375H | TYCO |
| JP5 | HDR102 | 2-PIN | 826629-2 | TH 100MIL SP 375H | TYCO |
| U1 | 2x3 uDFN-8 | | MC34674AEP | Single Cell Li+ Battery Charger IC, Linear | FREESCALE |

5 Component Selection

5.1 Input capacitor C1

The input capacitor is used to minimize the input voltage transient that may cause instability. A ceramic capacitor of 1.0μF or above is required for most applications. X5R and X7R dielectrics have better temperature stability. The evaluation board uses 1.0μF X5R ceramic capacitors. Considering the maximum input voltage rating of the MC34674 is 28V, the input capacitor must have 16V DC rated voltage.

5.2 Output capacitors C2, C3

The output capacitor is used for stable operation. A ceramic capacitor minimum of 2.2μF is required for the charger output. For the reference voltage output, a ceramic capacitor minimum of 0.1μF is required. On the evaluation board, C2 is a 2.2μF and C3 is a 1.0μF. Because the highest charge output voltage of the MC34674 is 4.2V and the VREF output voltage is 2.5V, a 6.3V DC rated voltage is high enough for the output capacitors.

5.3 Anti-ESD capacitors C4

The capacitor C4 at the TEMP pin is used to enhance the ESD protection at the TEMP pin as well as to filter the noise on the input voltage. Because R2 has a terminal exposed, the high voltage ESD at this terminal may damage the TEMP pin. A 0.01μF capacitance or above at the TEMP will protect the TEMP pin against ESD as high as 8KV HBM.

5.4 NTC interface resistor R1, R2

The MC34674 offers an interface to an external NTC inside the battery pack to monitor the battery temperature. The high and low temperature thresholds can be set by R1, R2, and the NTC value. If the temperature is out of the setting window, the charger is disabled to protect the battery. Meanwhile a temperature fault is issued with a yellow-color LED indication.

After the NTC is selected, the R1 and R2 value are determined by following equations:

$$R1 = 2(R_{COLD} - R_{HOT}) / 3$$

$$R2 = (R_{COLD} - 4R_{HOT}) / 3$$

Where R_{COLD} is the resistance of the thermistor at cold temperatures, such as 0°C, and R_{HOT} is the resistance of the thermistor at hot temperatures, such as 45°C.

On the evaluation board, a potentiometer P1 is acting as an NTC thermistor. R1 is 10K and R2 is 0Ohm. The user can evaluate the voltage threshold at the TEMP pin by using the potentiometer P1. If using an external NTC thermistor, make sure the pin header jumper JP5 is opened. R1 and R2 must be replaced by the value calculated by the above equations.

6 Layout Design

6.1 Layout

The KIT34674EPEVBE PCB board has two copper layers. The component side of the KIT34674EPEVBE is provided to locate all components. **Figure 3** is an overview of the board, followed by the layout of each layer.

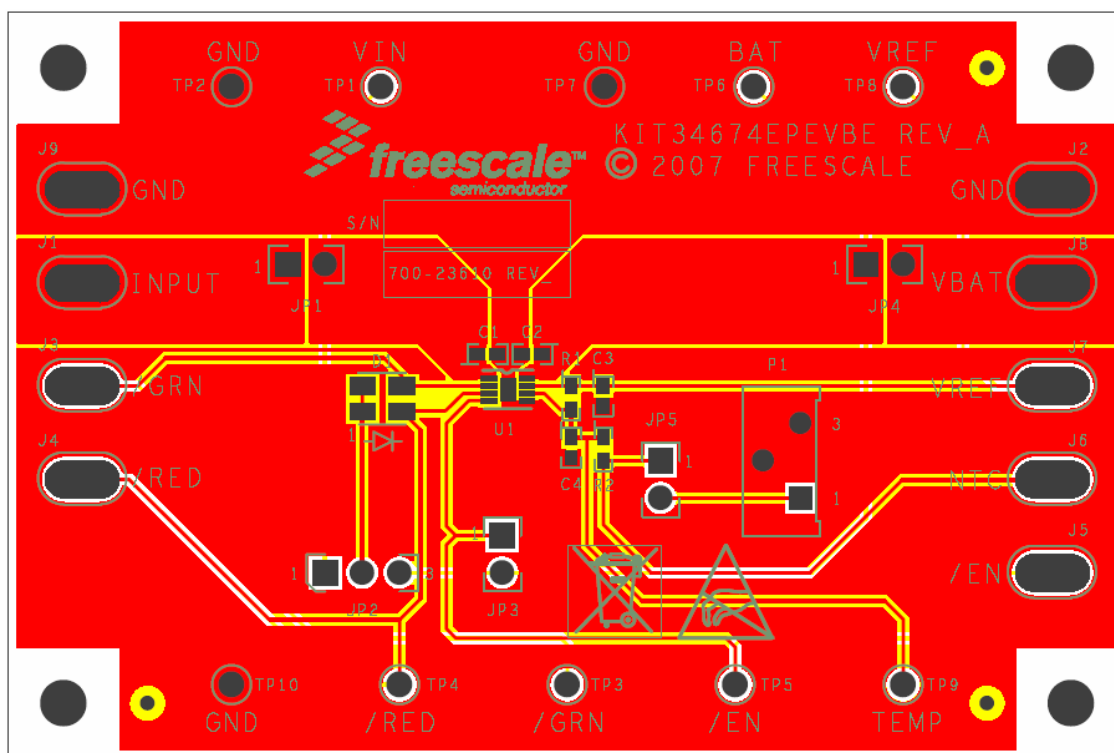


Figure 3. The Overview of the Evaluation Board

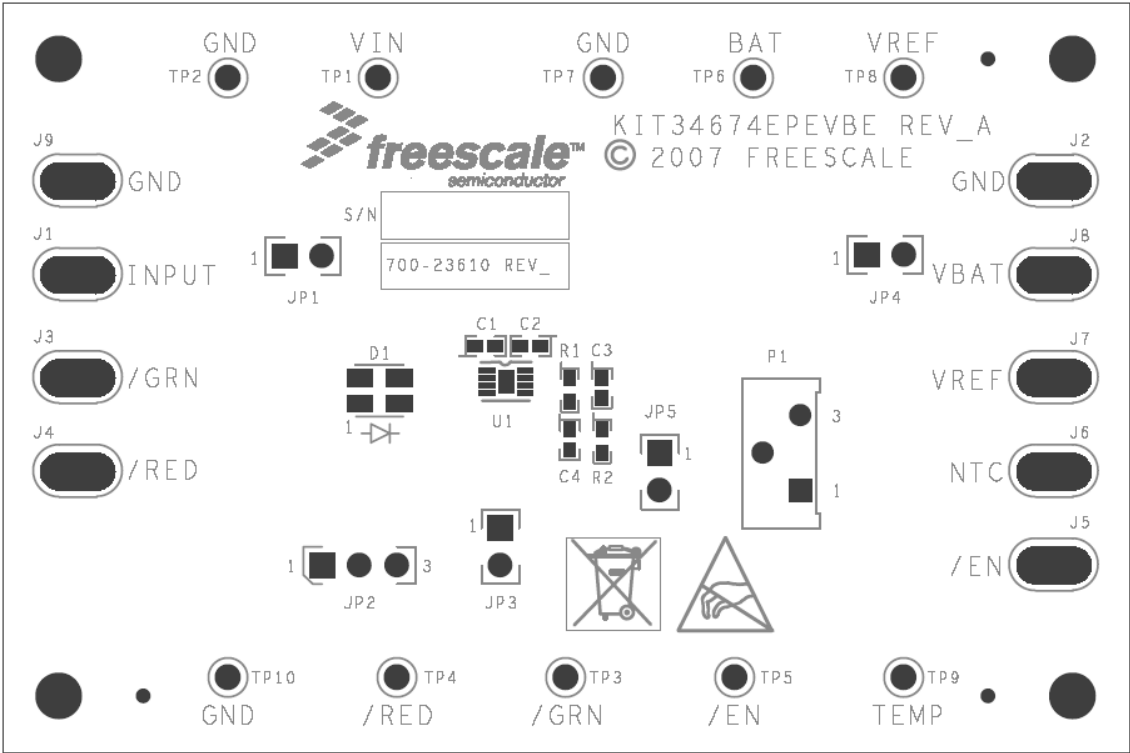


Figure 4. Silk Screen Layer

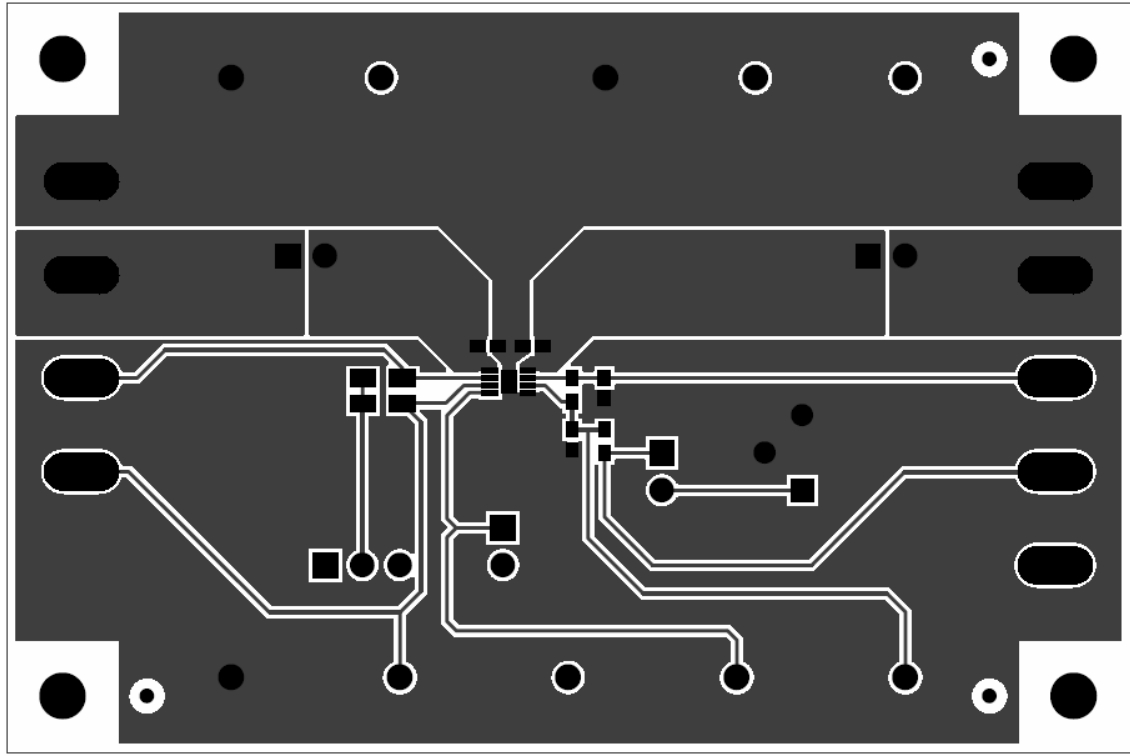


Figure 5. Component Side Layer

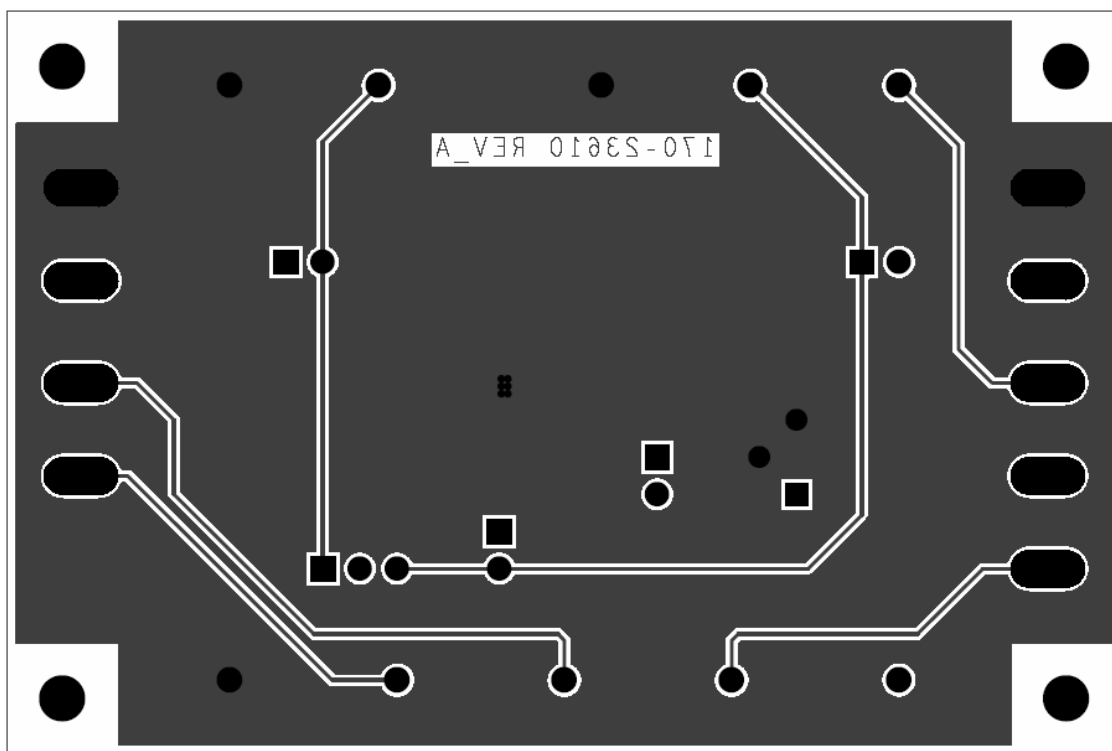


Figure 6. Solder Side Layer

6.2 Layout considerations

- Place decoupling capacitors C1, C2, and C3 as close as possible to the VIN pin, BAT pin, and VREF pin respectively.
- Use wide traces to connect input power to the VIN pin and BAT pin to the battery.
- To get better thermal performance, put the EPAD pin of the MC34674 on a large ground plane on the component side and use a via array to connect the EPAD pin to the ground layer or the large ground plane in the other layer.

7 Evaluation Board Configuration

7.1 Pin Headers

The JP1 pin header links the external DC power supply to the VIN pin of the MC34674. It allows the user to measure the current from the DC power supply to the evaluation board when using a current meter between pin 1 and pin 2 of JP1. The default setting of JP1 is to short pins 1 and 2.

The JP2 pin header selects the voltage to supply the D1 LED indicator. Shorting pins 1 and 2 selects VIN to power the LED. Shorting pins 2 and 3 selects BAT to power the LED.

IMPORTANT: DO NOT APPLY HIGHER THAN 12V DC INPUT VOLTAGE TO VIN IF PINS 1 and 2 ARE SHORTED.

Test Setup with the Evaluation Board

The absolute maximum voltage at the $\overline{\text{GRN}}$ and $\overline{\text{RED}}$ pin is 12V. When applying higher than 12V input voltage, select BAT to power the LED.

The JP3 pin header allows the user to disable the MC34674 when shorting pins 1 and 2. Leaving it open enables the MC34674.

The JP4 pin header links the BAT pin and the external battery connector. It allows the user to measure the charging current from the MC34674 into the battery with a current meter between pin 1 and pin 2. The default setting is to short pins 1 and 2.

JP5 lets the user use the potentiometer P1 on the evaluation board to simulate the NTC thermistor. When it is shorted, turning the P1 can evaluate the voltage threshold at TEMP pin. When it is opened, an NTC must be connected to the NTC pad of the board. The NTC interface resistors R1 and R2 must be replaced by the other value resistors with respect to the selected NTC

7.2 Connector Pads

There are 9 connecting pads (J1 to J9 with the corresponding names) on the evaluation board to let the user to simply connect the board to their system. The GND pads link power ground of the MC34674. The INPUT pad connects an external DC power supply to the evaluation board. The $\overline{\text{GRN}}$, $\overline{\text{RED}}$, EN, TEMP, and VREF pad link to the corresponding pins of the MC34674. The VBAT pad connects the positive pole of the Li+ battery being charged.

7.3 Test points

The KIT34674EPEVBE evaluation board provides 7 signal test points and 3 ground test points for users to conveniently hook up multi-meters and oscilloscope probes to evaluate the MC34674. The test points connect the pins of the MC34674 with the same name directly.

8 Test Setup with the Evaluation Board

The test setup is shown in [Figure 7](#). Connect a DC power source with a larger than 1.5A current limit to the INPUT pad on the evaluation board. Connect the positive and negative polarities of the Li+ battery to the VBAT pad and the GND pad on the evaluation board respectively. Use a current meter and a voltage meter to measure the charge current and the battery voltage respectively. Turn on the power supply and the evaluation board starts to charge the battery.

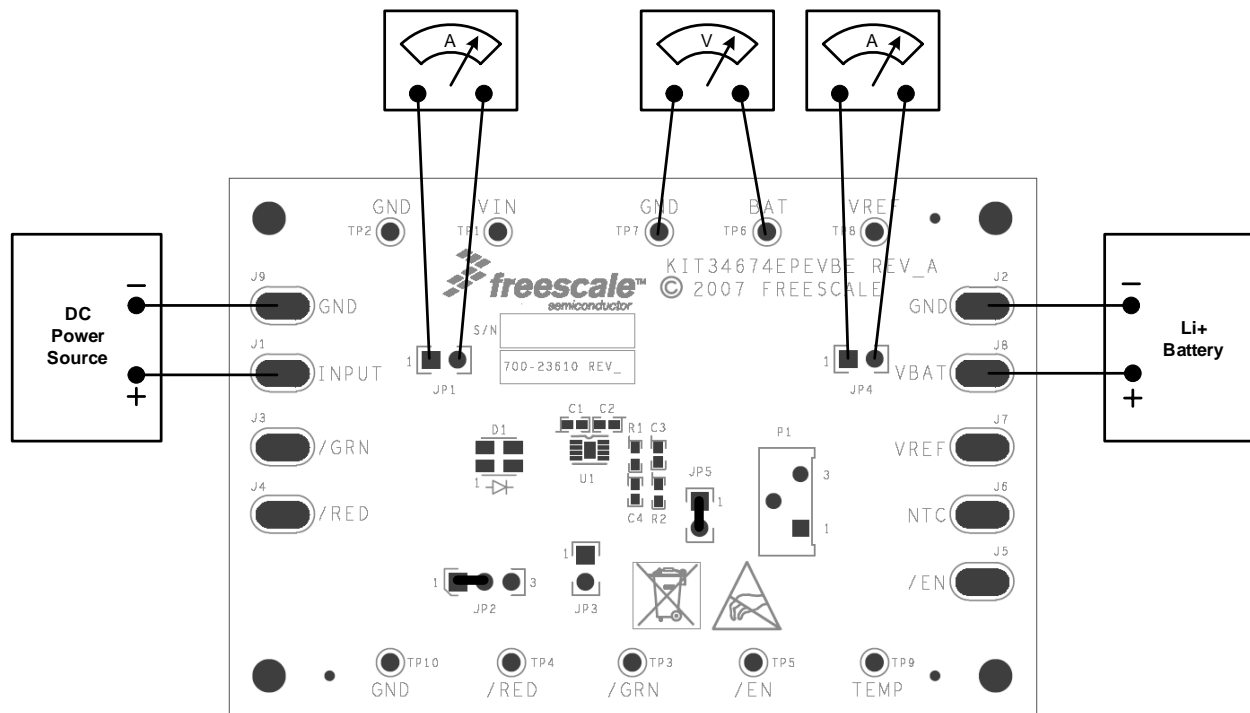


Figure 7. Test Setup

9 References

- MC34674PG Quick Reference
- MC34674 Data Sheet

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