Freescale Semiconductor
User's Guide

Document Number: KT34674UG
Rev. 1.0, 3/2008

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 ±0.4% output voltage accuracy and ±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

Contents

1 Purpose 1
2 Scope 1
3 Application Diagram 2
4 Evaluation Board Specification 2
5 Component Selection 4
6 Layout Design 5
7 Evaluation Board Configuration 7
8 Test Setup with the Evaluation Board 8
9 References 10

© Freescale Semiconductor, Inc., 2008. All rights reserved.

freescale™ semiconductor

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.

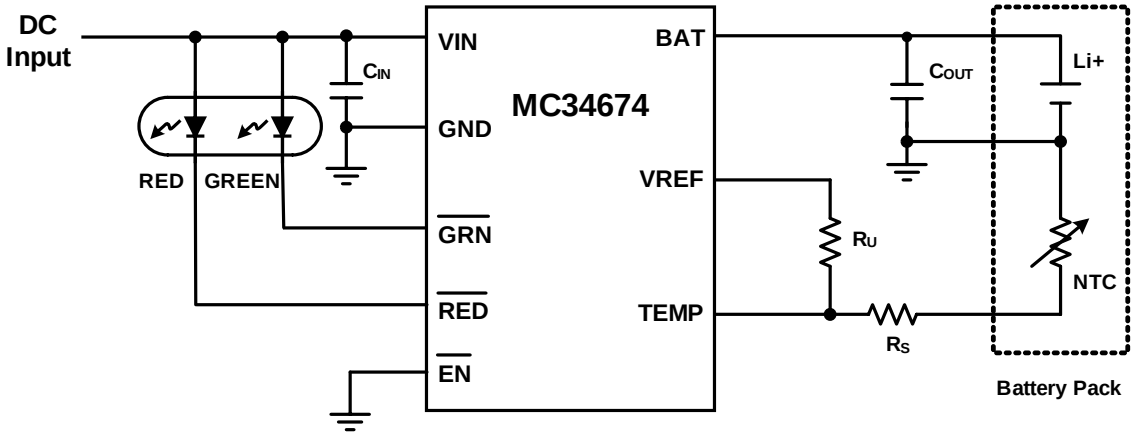


Figure 1. Typical Travel Charger

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

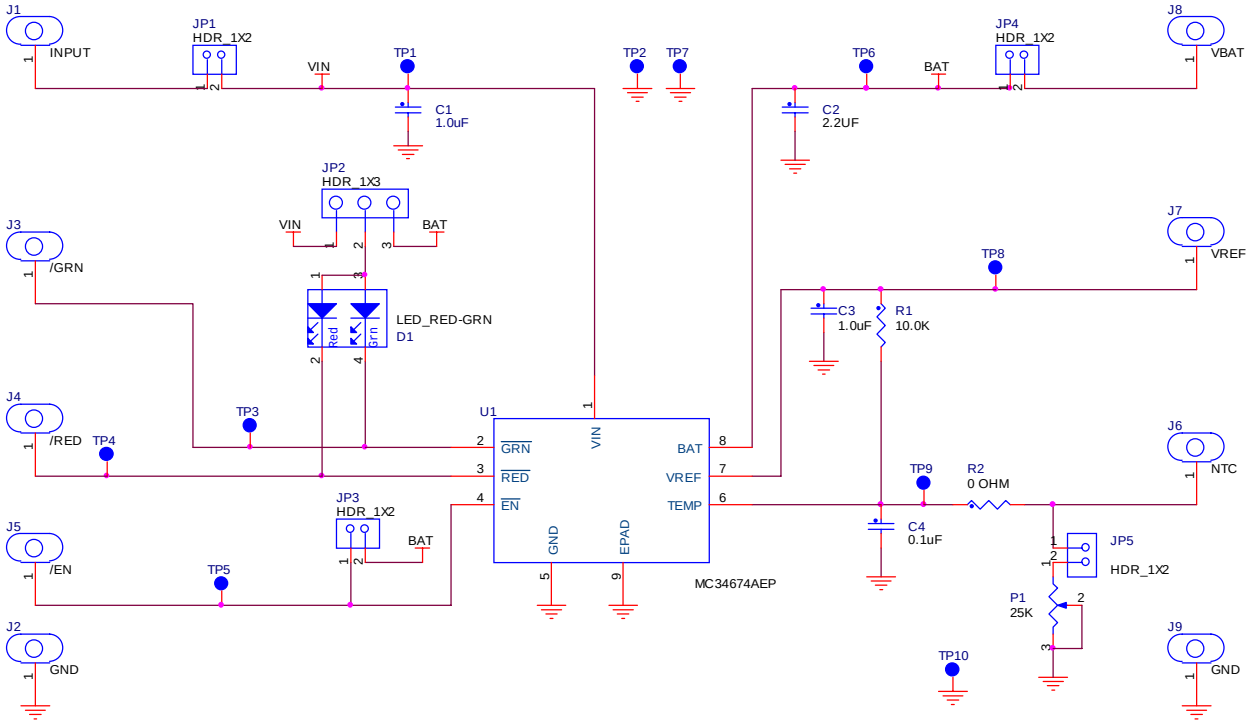


Figure 2. Schematic Circuit

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

Downloaded from Arrow.com.

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.

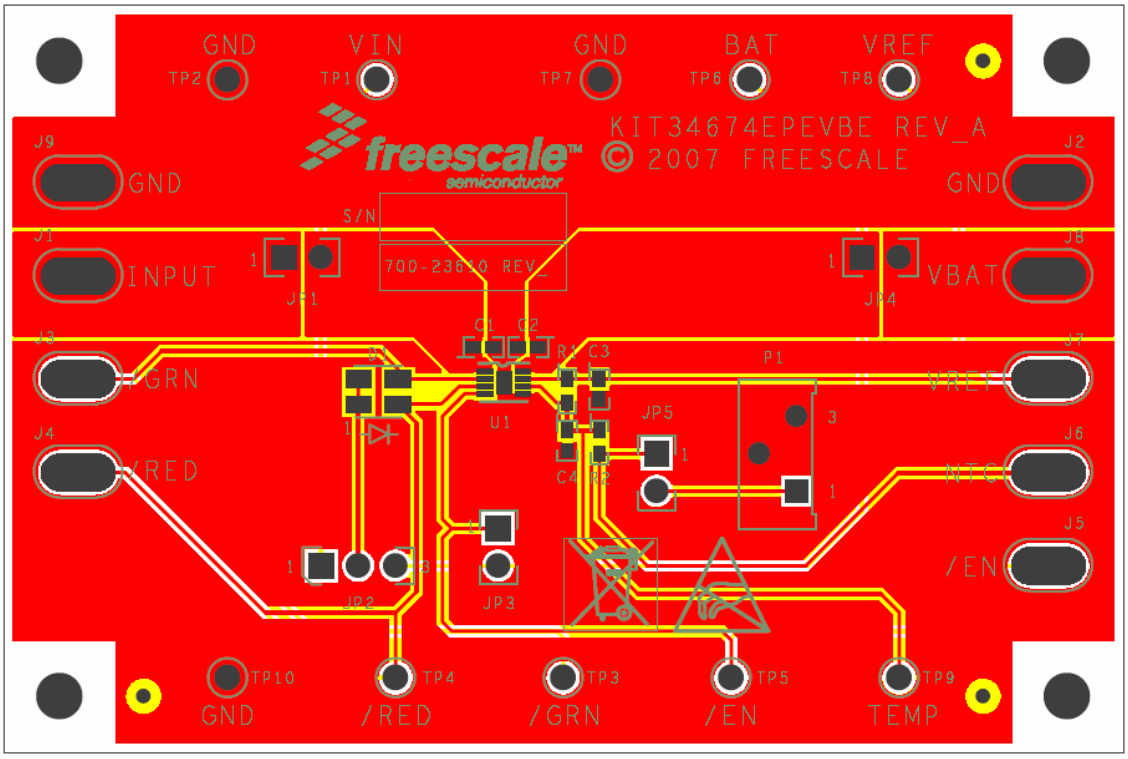


Figure 3. The Overview of the Evaluation Board

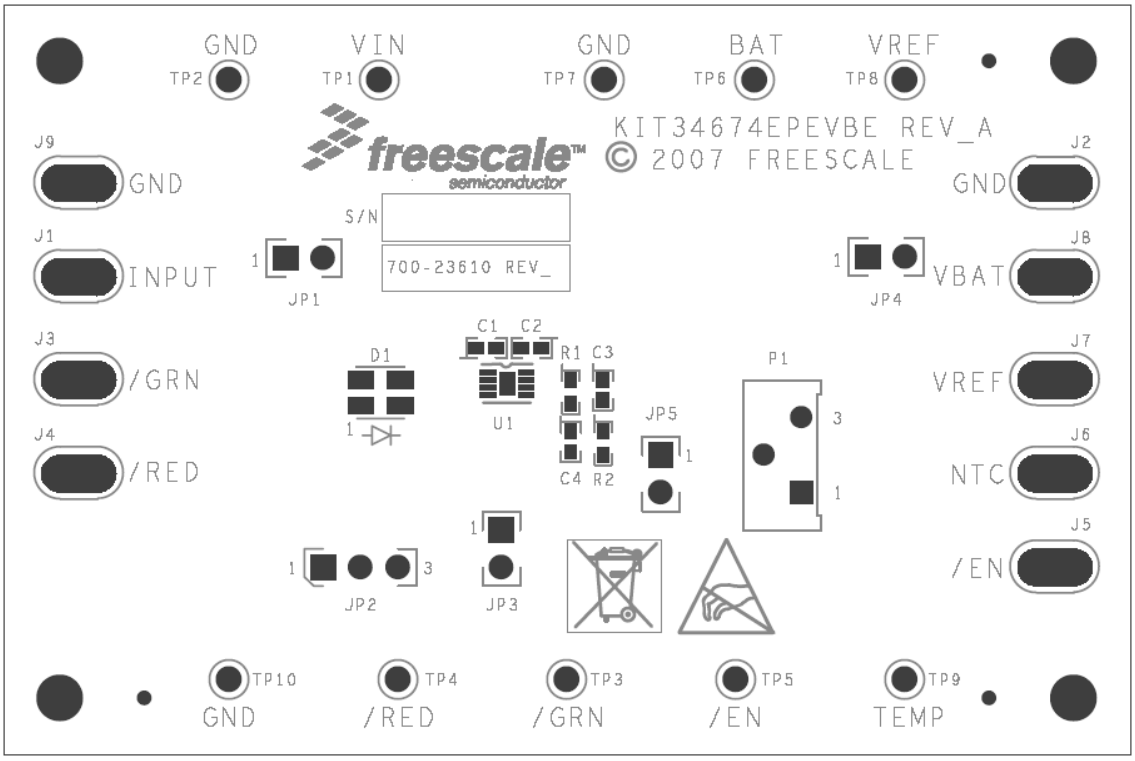


Figure 4. Silk Screen Layer

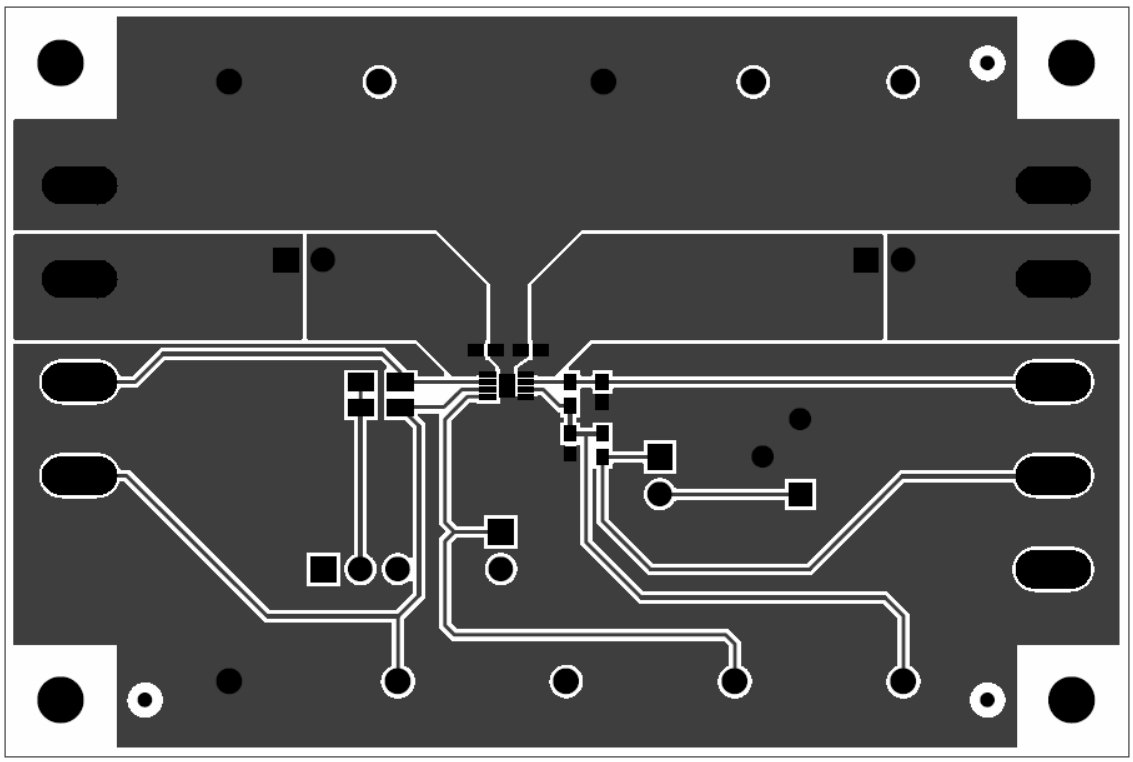


Figure 5. Component Side Layer

Downloaded from Arrow.com.

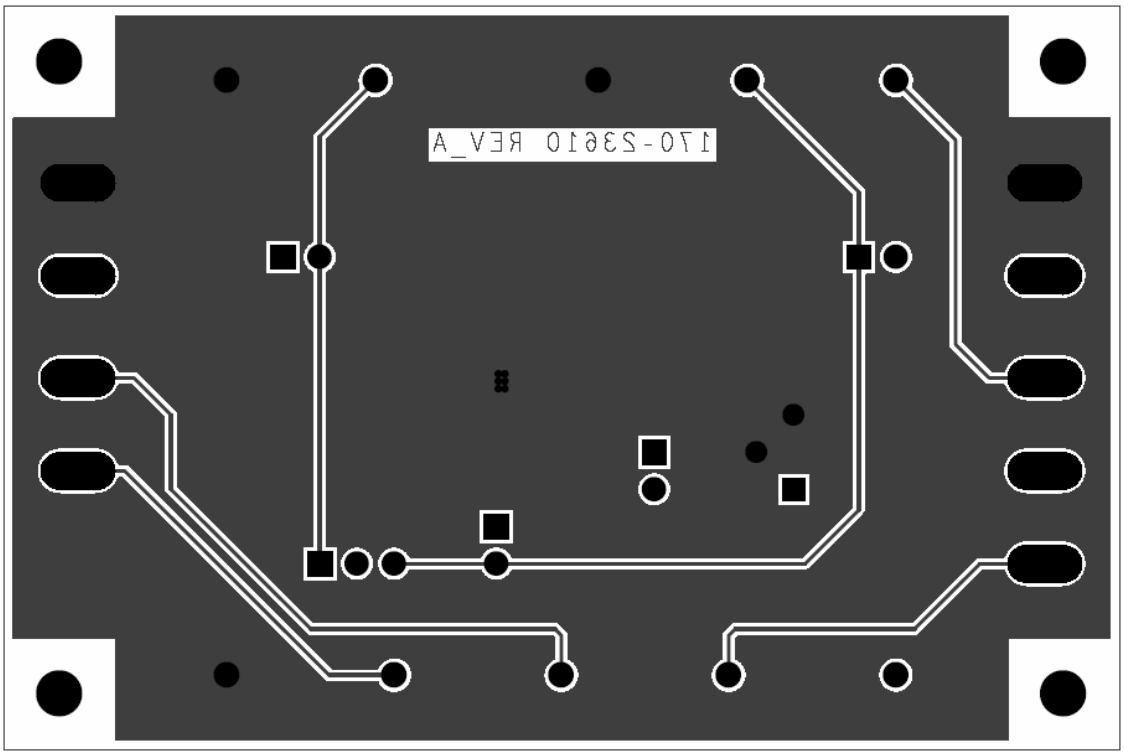


Figure 6. Solder Side Layer

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.

Downloaded from Arrow.com.

The absolute maximum voltage at the GRN and 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 GRN, 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.

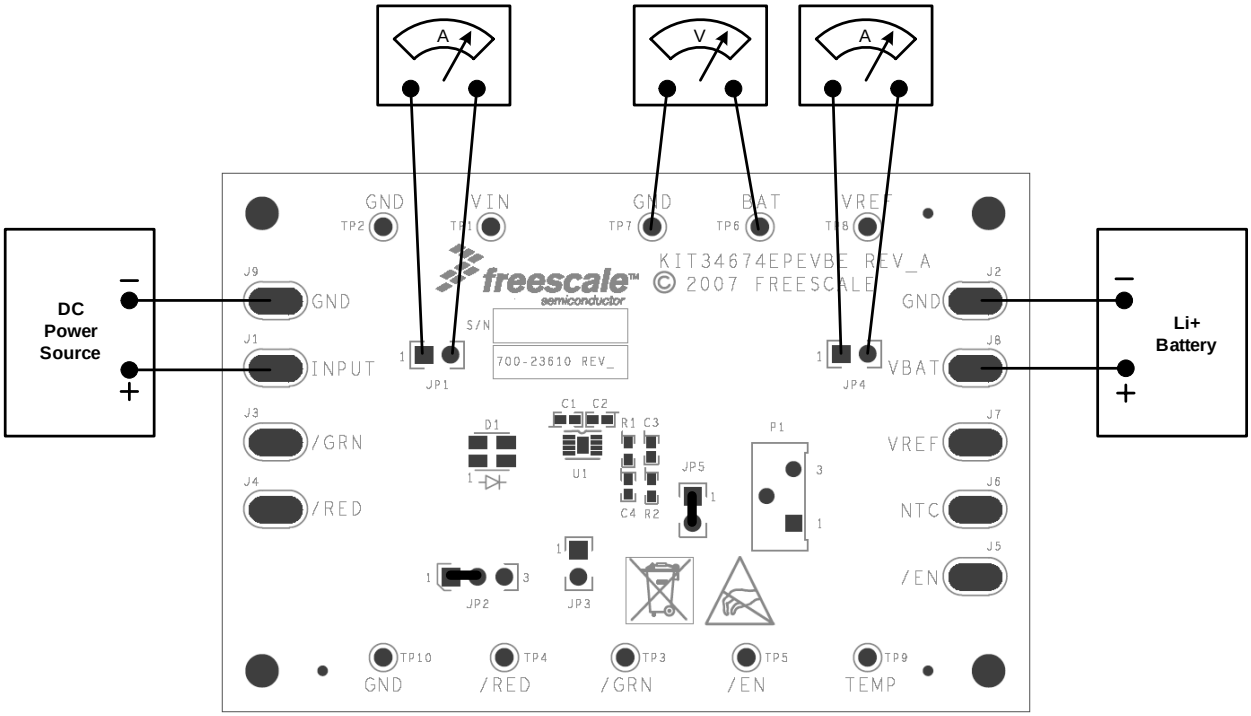


Figure 7. Test Setup

Downloaded from Arrow.com.

9 References

- MC34674PG Quick Reference
- MC34674 Data Sheet

How to Reach Us:

Home Page:
www.freescale.com

Web Support:
http://www.freescale.com/support

USA/Europe or Locations Not Listed:
Freescale Semiconductor, Inc.
Technical Information Center, EL516
2100 East Elliot Road
Tempe, Arizona 85284
+1-800-521-6274 or +1-480-768-2130
www.freescale.com/support

Europe, Middle East, and Africa:
Freescale Halbleiter Deutschland GmbH
Technical Information Center
Schatzbogen 7
81829 Muenchen, Germany
+44 1296 380 456 (English)
+46 8 52200080 (English)
+49 89 92103 559 (German)
+33 1 69 35 48 48 (French)
www.freescale.com/support

Japan:
Freescale Semiconductor Japan Ltd.
Headquarters
ARCO Tower 15F
1-8-1, Shimo-Meguro, Meguro-ku,
Tokyo 153-0064
Japan
0120 191014 or +81 3 5437 9125
support.japan@freescale.com

Asia/Pacific:
Freescale Semiconductor Hong Kong Ltd.
Technical Information Center
2 Dai King Street
Tai Po Industrial Estate
Tai Po, N.T., Hong Kong
+800 2666 8080
support.asia@freescale.com

For Literature Requests Only:
Freescale Semiconductor Literature Distribution Center
P.O. Box 5405
Denver, Colorado 80217
1-800-441-2447 or 303-675-2140
Fax: 303-675-2150
LDCForFreescaleSemiconductor@hibbertgroup.com

RoHS-compliant and/or Pb-free versions of Freescale products have the functionality and electrical characteristics of their non-RoHS-compliant and/or non-Pb-free counterparts. For further information, see http://www.freescale.com or contact your Freescale sales representative.

For information on Freescale's Environmental Products program, go to http://www.freescale.com/epp.

Information in this document is provided solely to enable system and software implementers to use Freescale Semiconductor products. There are no express or implied copyright licenses granted hereunder to design or fabricate any integrated circuits or integrated circuits based on the information in this document.

Freescale Semiconductor reserves the right to make changes without further notice to any products herein. Freescale Semiconductor makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does Freescale Semiconductor assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation consequential or incidental damages. "Typical" parameters that may be provided in Freescale Semiconductor data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals", must be validated for each customer application by customer's technical experts. Freescale Semiconductor does not convey any license under its patent rights nor the rights of others. Freescale Semiconductor products are not designed, intended, or authorized for use as components in systems intended for surgical implant into the body, or other applications intended to support or sustain life, or for any other application in which the failure of the Freescale Semiconductor product could create a situation where personal injury or death may occur. Should Buyer purchase or use Freescale Semiconductor products for any such unintended or unauthorized application, Buyer shall indemnify and hold Freescale Semiconductor and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that Freescale Semiconductor was negligent regarding the design or manufacture of the part.

Freescale™ and the Freescale logo are trademarks of Freescale Semiconductor, Inc. All other product or service names are the property of their respective owners.

© Freescale Semiconductor, Inc., 2008. All rights reserved.

KT34674UG
Rev. 1.0
3/2008

freescale™ semiconductor