

5A Single Cell Li-Ion Switching Battery Charger With Direct Charge, Power Path Management and USB OTG Boost Mode

Purpose

The RT9468 is a switch-mode single cell Li-Ion/Li-Polymer battery charger for portable applications. It integrates a synchronous PWM controller, power MOSFETs, input current sensing and regulation, high-accuracy voltage regulation, and charge termination. The charge current is regulated through integrated sensing resistors. The RT9468 also features USB On-The-Go (OTG) support. The RT9468 integrates an easy-to-use direct charge function, simply driving an external MOSFET to enable a direct charge path, as well as over-voltage protection, over-current protection, and watchdog functions. This document explains the function and use of the RT9468 evaluation board (EVB), and provides information to enable operation, modification of the evaluation board and circuit to suit individual requirements.

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Introduction

General Product Information

The RT9468 is a switch-mode single cell Li-Ion/Li-Polymer battery charger for portable applications. It integrates a synchronous PWM controller, power MOSFETs, input current sensing and regulation, high-accuracy voltage regulation, and charge termination. The charge current is regulated through integrated sensing resistors. The RT9468 also features USB On-The-Go (OTG) support. The RT9468 integrates an easy-to-use direct charge function, simply driving an external MOSFET to enable a direct charge path, as well as over-voltage protection, over-current protection, and watchdog functions.

Product Feature

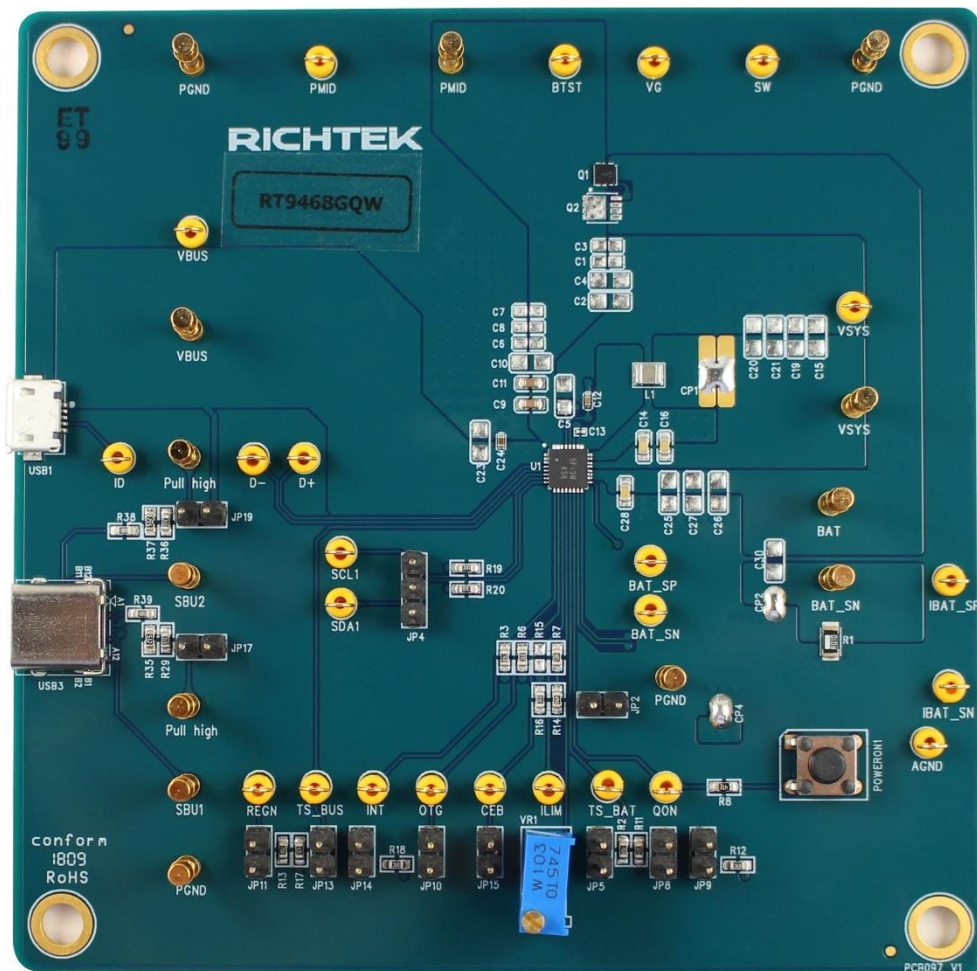
- **Direct Charge with Over-Voltage Protection, Over-Current Protection and Watchdog**
- **High Efficiency 5A, 1.5MHz Switching Charger with Output Inductor DFE252012F, TOKO**
 - ▶ **Charging Efficiency 90.25% at ICHG = 2A**
 - ▶ **Charging Efficiency 88.86% at ICHG = 3A**
 - ▶ **Charging Efficiency 84.2% at ICHG = 5A**
- **Synchronous 1.5MHz/0.75MHz Fixed-Frequency PWM Controller with Up to 95% Duty Cycle**
- **Power Path Management by BATFET Control**
- **Support High Voltage Input (9V/12V)**
- **Support High Voltage Input Adapter (Pump Express 1.0/2.0/3.0)**
- **Support IR Compensation Function from Charger Output to Cell Terminal**
- **Optimize Input Sourcing Capability to Prevent Overload**
 - ▶ **AICR Current Limit Setting via I²C**
 - ▶ **ILIM Pin for Current Limit Setting**
 - ▶ **Average Input Current Limit Measurement**
- **Shipping Mode for Battery Leakage Reduction**
 - ▶ **Wake Up System, Exit Shipping Mode, and Reset System by \overline{QON} Pin**
- **Automatic Charging**
- **Average Input Current Regulation (AICR) : 0.1A to 3.25A in 50mA Steps**
- **Charge Current Regulation Accuracy : $\pm 7\%$**
- **Charge Voltage Regulation Accuracy : $\pm 1\%$ (0 to 85°C)**
- **Protection for Overall System Considerations**
 - ▶ **Thermal Regulation for Current Reduction and Over-Temperature Protection**
 - ▶ **Input Over-Voltage Protection**
 - ▶ **Input Bad Adapter Protection**
 - ▶ **Battery Over-Voltage Protection**
- **Support ADC Conversion for**
 - ▶ **VBUS, VBAT, VSYS, REGN, TS_BAT, IBUS, IBAT,TEMP_JC, TS_BUS, VBATS, IBATS**
- **INT Output for Communication with Host Through I²C (Watch Dog / Polling Function)**

Key Performance Summary Table

Key Features	Evaluation Board Number : PCB097_V1
Input Voltage	3.9V to 14V
Output Voltage	3.8V to 5.06V
Maximum Output Current	0A to 5A
Package Type	RT9468GQW, WQFN-32L 4x4

Bench Test Setup Conditions

Headers Description and Placement



Carefully inspect all the components used in the EVB according to the following Bill of Materials table, and then make sure all the components are undamaged and correctly installed. If there is any missing or damaged component, which may occur during transportation, please contact our distributors or e-mail us at evb_service@richtek.com.

Test Points

The EVB is provided with the test points and pin names listed in the table below.

Test point/ Pin name	Signal	Comment (expected waveforms or voltage levels on test points)
VBUS	Input	Power input.
D+	USB D+ Port	Connected to USB receptacle.
D-	USB D- Port	Connected to USB receptacle.
TS_BUS	BUS Temperature-Sense Input	Connected to a resistor divider for temperature programming. If there is no need for the battery temperature-sense function, a 50kΩ resistor is connected to REGN and another 50kΩ resistor to ground.
SCL	I ² C Interface Serial Clock Input	Open-drain. An external pull-up resistor is required.
SDA	I ² C Interface Serial Data Input/Output	Open-drain. An external pull-up resistor is required.
INT	Interrupt output	Active-low open-drain. Indicator of the charger/boost event for system processor.
OTG	OTG Boost Mode Enable Control	Active-high. Act with OTG_PIN_EN (0x01[1]).
CEB	Charger Enable Input	Active-low.
ILIM	Input Current Limit Setting Pin	A resistor is connected from ILIM pin to ground to set the maximum input current limit. The actual input current limit is the lower value set through the ILIM pin and IAICR register bits.
TS_BAT	Battery Temperature-Sense Input	connected to a resistor divider for temperature programming. If there is no need for the battery temperature-sense function, a 50kΩ resistor is connected to REGN and another 50kΩ resistor to ground.
QON	Internal BATFET Enable Control Input	In shipping mode, \overline{QON} is pulled Low for the duration of tSHIPMODE (typical 0.9s) to exit shipping mode.
IBAT_SN	Negative Battery Current Sense	Negative battery current sense. Connect a 10mΩ between IBAT_SP.
IBAT_SP	Positive Battery Current Sense	Positive battery current sense. Connect a 10mΩ between IBAT_SN.
BAT_SN	Negative Battery Current Sense	Connect to battery connect.
BAT_SP	Positive Battery Current Sense	Connect to battery connect.
BAT	Battery Connection Node	Charging current output node. Internal BATFET is connected between SYS and BAT.
SYS	System Connection Node	The internal BATFET is connected between SYS and BAT. Connect a 20μF ceramic capacitor between SYS and ground.
SW	Switch Node	Switch node for output inductor connection.
BTST	Bootstrap Capacitor Connection for High-Side Gate Driver	Connect a capacitor from BTST to SW to power the internal gate driver.
REGN	Regulated Output Voltage	Connect a 4.7μF ceramic capacitor from REGN to GND.
VG	Gate Driver Output	Gate driver output for external N-MOSFET.
PMID	PMID	Connection point between the reverse blocking MOSFET and the high-side switching MOSFET.

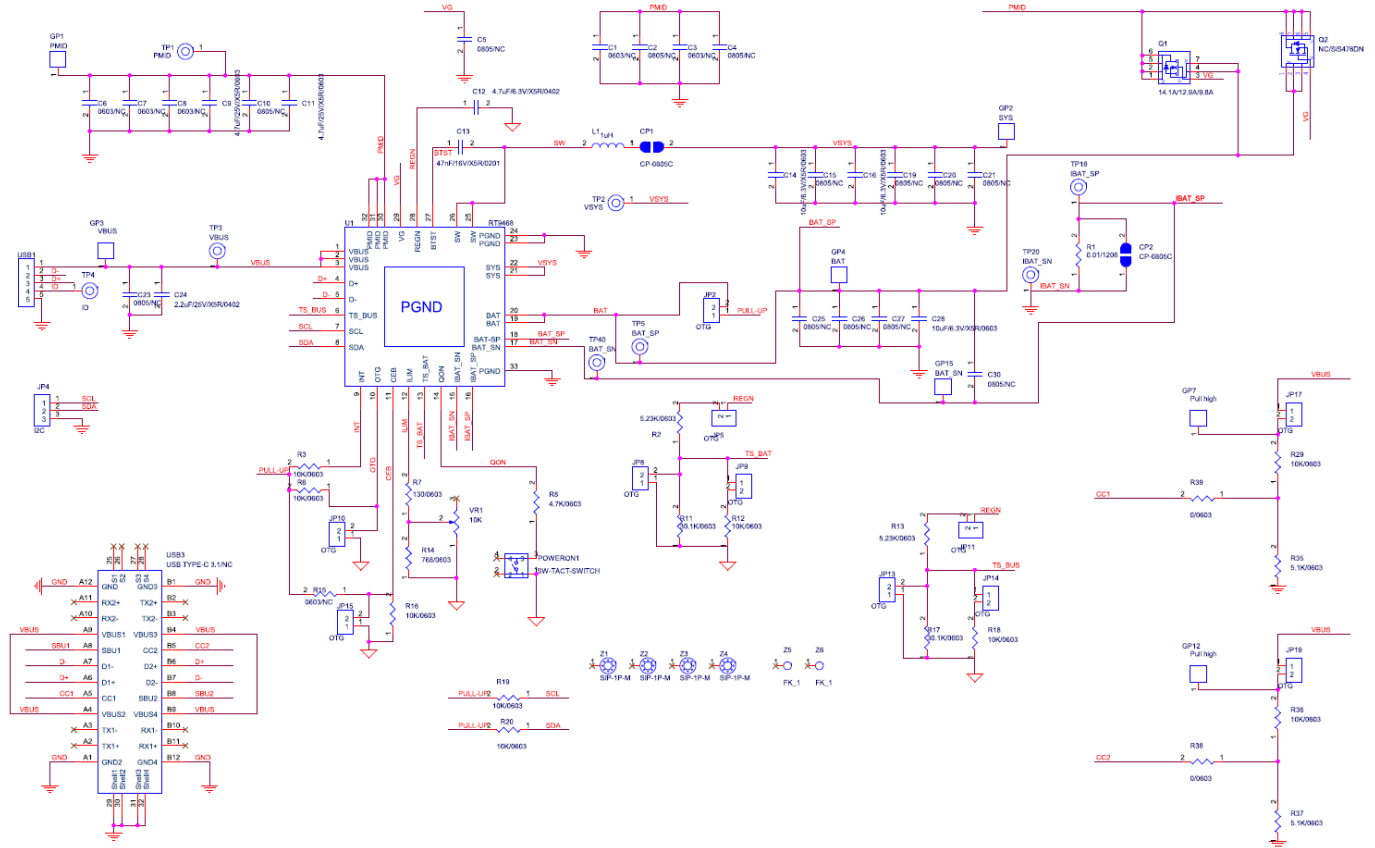
Test point/ Pin name	Signal	Comment (expected waveforms or voltage levels on test points)
PGND	Power Ground	Power ground connection. The exposed pad must be connected to GND and well soldered to a large PCB copper area for maximum power dissipation.

Power-Up & Measurement Procedure

1. Connect input power ($5 < V_{BUS} < 14V$) and input ground to VIN and GND test pins respectively.
2. Connect positive end and negative terminals of VBAT to BAT and BAT_SN test pins respectively.
3. Connect JP11, JP14, JP5 and JP9 let TS_BUS and TS_BAT at normal condition.

Schematic, Bill of Materials & Board Layout

EVB Schematic Diagram

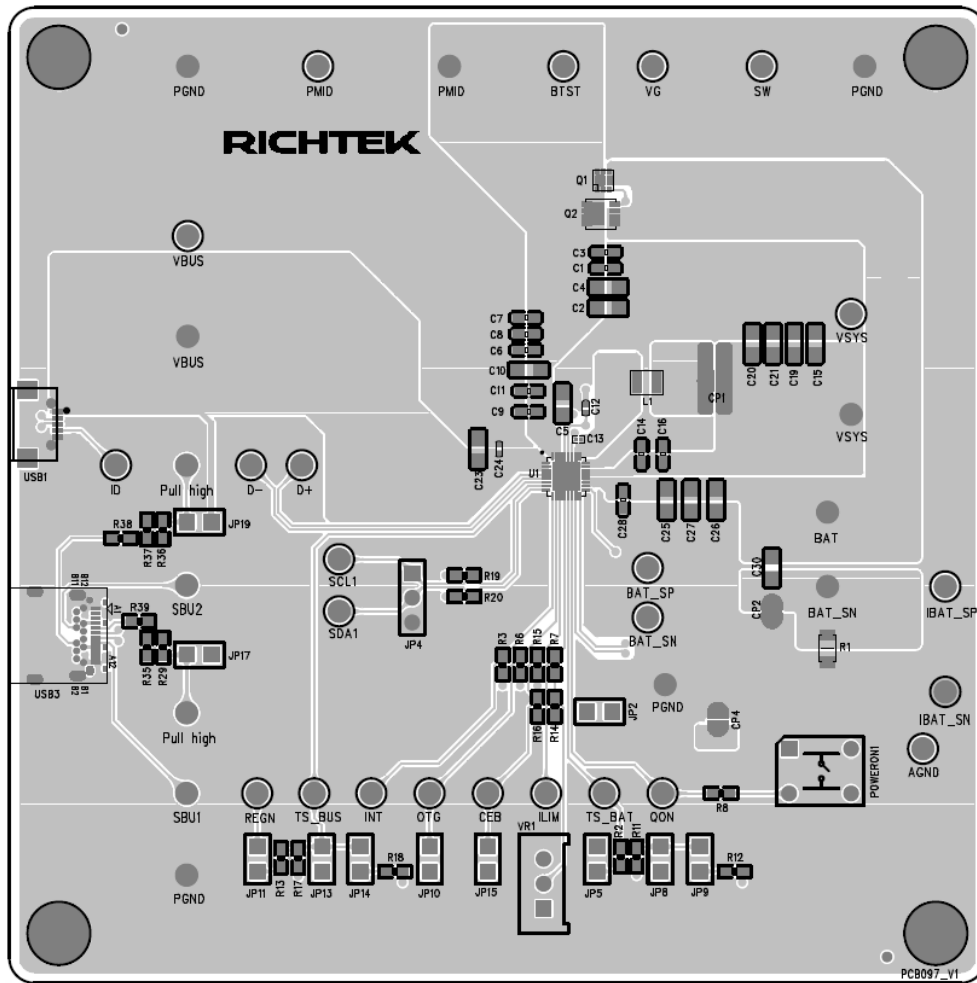


Bill of Materials

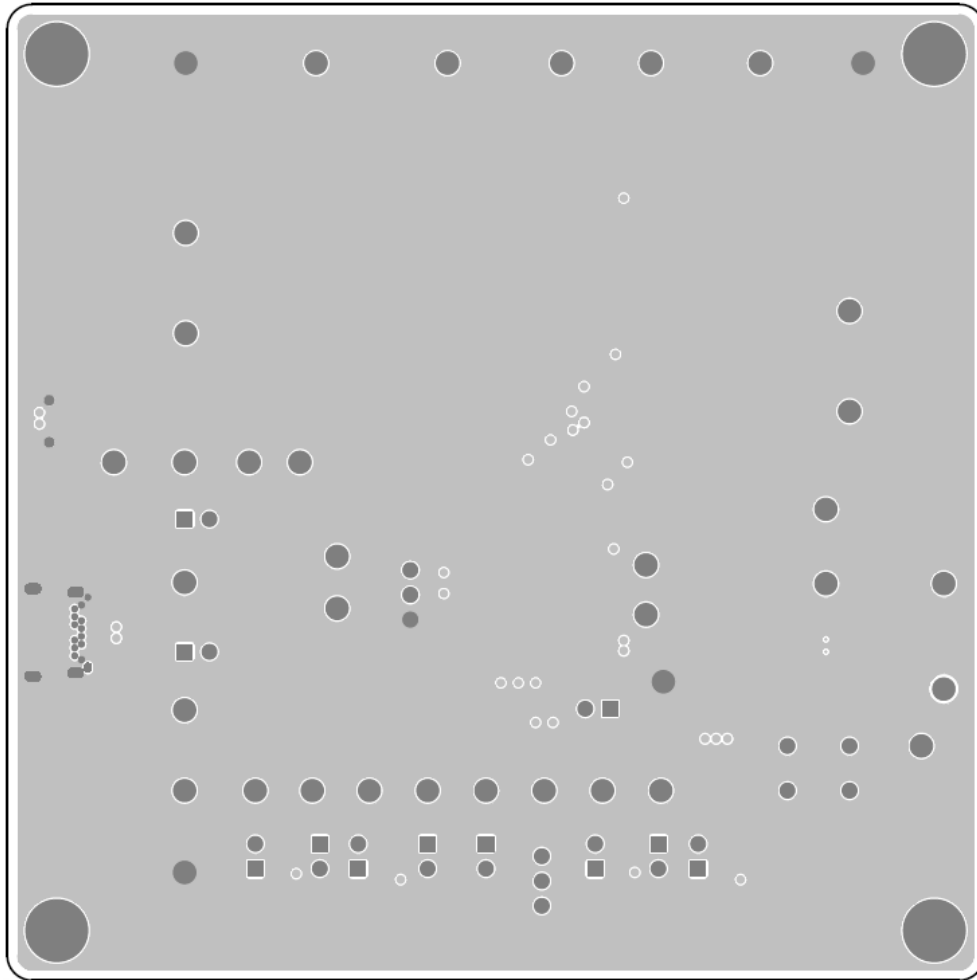
Reference	Qty	Part Number	Description	Package	Manufacturer
C9, C11	2	GRM188R61E475KE11	4.7μF/25V/X5R	0603	muRata
C12	1	GRM155R60J475ME47	4.7μF/6.3V/X5R	0402	muRata
C13	1	GRM033R61C473KE84	47nF/16V/X5R	0201	muRata
C14, C16, C28	3	GRM185R60J106ME15	10μF/6.3V/X5R	0603	muRata
C24	1	GRM155R61E225KE11	2.2μF/25V/X5R	0402	muRata
L1	1	DFE252012F-1R0M	1μH	2.5x2.0mm	muRata
Q1	1	DMT2004UFD	NMOS	2x2x0.6mm	DIODES
U2	1	RT9468GQW	Switching Charger	WQFN-32L 4x4	Richtek
R1	1	WR06X5231FTL	5.23k/0603	1206	WELLCOMP TECHNOLOGY
R2, R13	2	WR06X1002FTL	10k/0603	0603	WALSIN
R3, R6, R12, R16, R18, R19, R20, R29, R36	9	WR06X1300FTL	130/0603	0603	WALSIN
R7	1	WR06X4701FTL	4.7k/0603	0603	WALSIN

Reference	Qty	Part Number	Description	Package	Manufacturer
R8	1	WR06X3012FTL	30.1k/0603	0603	WALSIN
R11, R17	2	WR06X7680FTL	768/0603	0603	WALSIN
R14	1	WR06X5231FTL	5.23k/0603	0603	WALSIN
R35, R37	2	WR06X5101FTL	5.1k/0603	0603	WALSIN
R38, R39	2	WR06X000 PTL	0/0603	0603	WALSIN
USB1	1		SIP-5P	USB-MICRO-TC U-S60M	
USB3	1	121U-3CST-09CR	USB TYPE-C 3.1	9.87x9.75mm	JEM (建舜電子)

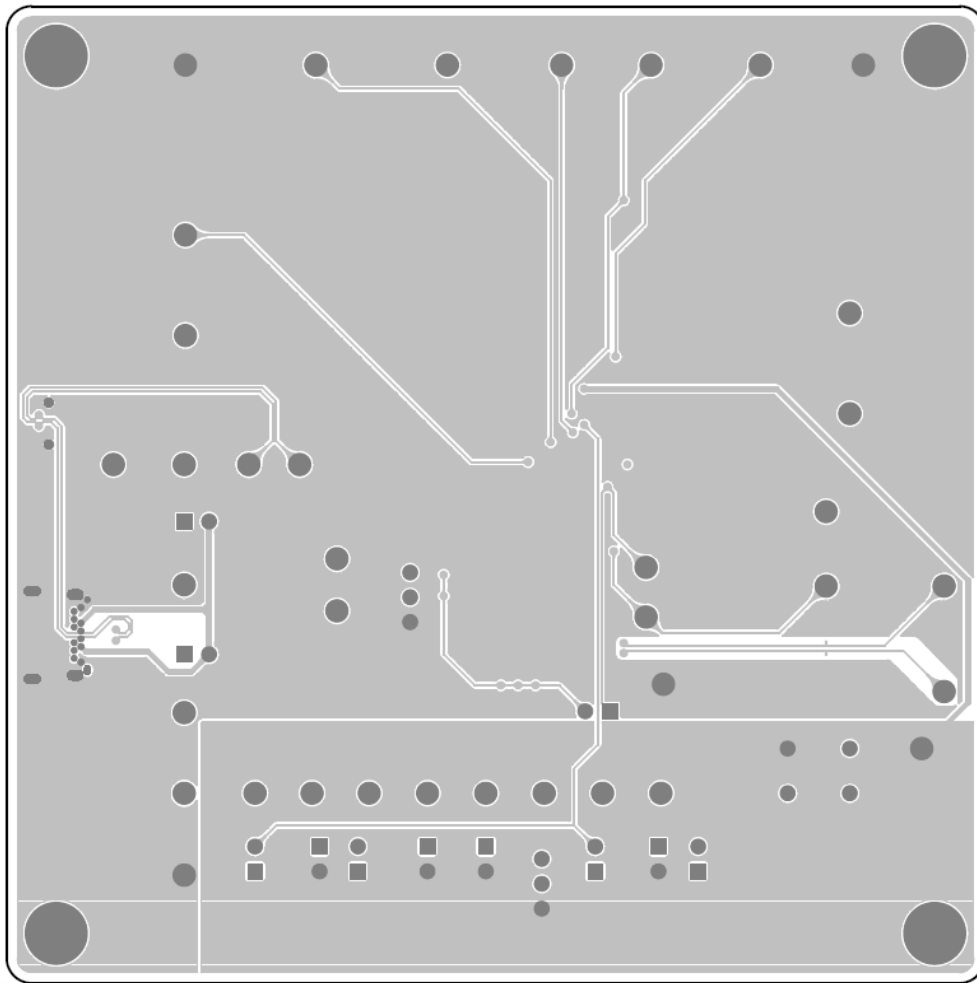
PCB Layout



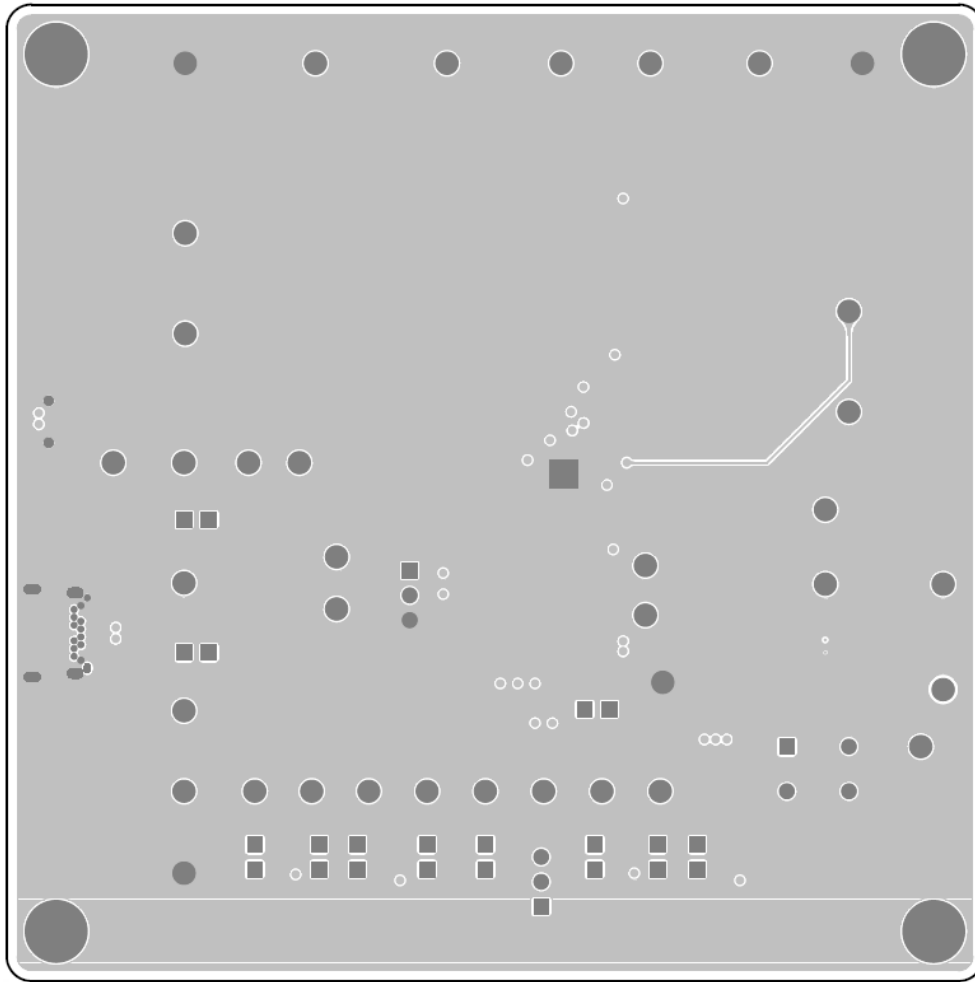
Top View (1st layer)



PCB Layout—Inner Side (2nd Layer)



PCB Layout—Inner Side (3rd Layer)



Bottom View (4th Layer)

More Information

For more information, please find the related datasheet or application notes from Richtek website <http://www.richtek.com>.

Important Notice for Richtek Evaluation Board

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