

High Accuracy Current and Power Monitor Evaluation

Board

General Description

This document provides information on the function and use of the RTQ6059 evaluation board (EVB), as well as instructions for operating and modifying the board and circuit to meet individual requirements. Additionally, it includes details on the schematic diagram, bill of materials, and evaluation board layout.

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Performance Specification Summary

Summary of the RTQ6059GJ8 Evaluation Board performance specificiaiton is provided in Table 1. The ambient temperature is 25°C.

			,		
Specification	Test Conditions	Min	Тур	Max	Unit
Default Input Voltage	Default = 12V	0		32	V
Supply Voltage	Default = 3.3V	3		5.5	V
Sensing Current			0.5		А
4 L CD Stop Size	Sense voltage		10		μV
I LOB Step Size	Bus voltage		4		mV
Quiessant Current	$T_A = 25^{\circ}C$		0.7	1	mA
Quiescent Current	Shutdown mode		6	15	μA

Table 1. RTQ6059GJ8 Evaluation Board Performance Specification Summary

Power-up Procedure

Suggestion Required Equipments

- DC Power Supply (Chroma, 62006P-100-25)
- Electronic load capable of 6A
- Richtek Wrenboard



Figure1. High-Side Configuration

Quick Start Procedures

- 1. Apply $V_S = 3.3V$ input power supply ($3V < V_S < 5.5V$) to VS and GND terminals.
- 2. Apply 12V input power voltage (0V < IN + < 32V) to the IN+ and GND terminals.
- 3. The default sense resistance is $100m\Omega$.
- 4. Connect an external load to the IN- and GND terminals, and keep loading current = 0.5A.
- 5. Measure the sense voltage (approximately 50mV) between the IN+ and IN-.
- 6. Use the RTQ6059 GUI to check practical sense voltage, bus voltage, current, and power.



Detailed Description of Hardware

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 <u>evb_service@richtek.com</u>.

Test Points

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

Test Point/ Pin Name	Function
A1, A0	Slave address selection.
SCL	I ² C communication connection.
SDA	I ² C communication connection.
IN+	Positive current-sensing input.
IN-	Negative current-sensing input.
VS	Power supply, 3V to 5.5V.

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RTQ6059 Evaluation Board Jumper Default Settings

Figure 2 displays the default jumper settings of the RTQ6059 Evaluation Board. The initial slave address, as indicated in Table 2, is 0x40 (Hex). To modify the slave address, the position of the jumper can be altered.



Figure 2. Slave Address Default Setting

Table 2. Slave Addresses Selection

A1	A0	Slave Address	Slave Address (Hex)
GND	GND	1000000	40
GND	VS	1000001	41
GND	SDA	1000010	42
GND	SCL	1000011	43
VS	GND	1000100	44
VS	VS	1000101	45
VS	SDA	1000110	46
VS	SCL	1000111	47
SDA	GND	1001000	48
SDA	VS	1001001	49
SDA	SDA	1001010	4A
SDA	SCL	1001011	4B
SCL	GND	1001100	4C
SCL	VS	1001101	4D
SCL	SDA	1001110	4E
SCL	SCL	1001111	4F

IN+ and IN- Input RC Filter

The RTQ6059 Evaluation Board features an RC filter option to shield the IN+ and IN- inputs from high-frequency noise. As depicted in Figure 3, the default settings are 0Ω for resistance and 0.1μ F for capacitance.





Figure 3. Input Filter Setting

Freely Choose between High-Side or Low-Side

Figure 1 shows the RTQ6059 Evaluation Board in a high-side configuration. To switch to a low-side configuration, as per Figure 4, short the VIN- pin to GND, connect VIN+ to Load +, connect Load - to PSU2 +, and short PSU2 to GND. According to the design architecture, Low-Side Configuration is only suitable for current measurement. This configuration method involves connecting the measurement device between the load and the ground, allowing for the direct measurement of the current passing through the load.



Figure 4. Low-Side Configuration



RichTek WrenBoard Driver Installation

To use the WrenBoard developed by Richtek, it is necessary to first install the driver. Follow the steps below to complete the driver installation, and then the WrenBoard will be ready for use. As shown in Figure 5, click on "Richtek Bridgeboard Utilities" and then press the "Install" button to begin the installation.

Richtek Bridgeboard Utilities - InstallShield Wizard	
Richtek Bridgeboard Utilities requires the following items to be installed on your computer. Click Install to begin installing these requirements.	
Status Requirement Pending Microsoft Visual C++ 2008 Redistributable Package (x86) Pending Richtek Auto Update EngineV16	
Install Cancel	

Figure 5. Driver Installation Step 1

As seen in Figure 6, wait for the installation to proceed. During the installation process, a window will pop up, as shown in Figure 7. At this point, press the "YES" button to continue with the installation.



Figure 6. Driver Installation Step 2



Richtek Bridgeboard Utilities - InstallShield Wizard
Richtek Bridgeboard Utilities requires the following items to be installed on your computer. Click Install to begin installing these requirements.
Status Requirement
Failed Microsoft Visual C++ 2008 Redistributable Package (x86)
Richtek Bridgeboard Utilities - InstallShield Wizard ×
The installation of Microsoft Visual C++ 2008 Redistributable Package (x86) appears to have failed. Do you want to continue the installation?
In 是(Y) 否(N)
Install Cancel

Figure 7. Driver Installation Step 3

The installation will continue at this point. Wait for the installation process to proceed further, as shown in Figure 8.



Figure 8. Driver Installation Step 4

After clicking the "Next" button in Figure 9, the License Agreement screen, as shown in Figure 10, will appear. Choose to accept and continue by clicking the "Next" button. Then, after confirming the relevant information in Figure 11, you can click the "Next" button again.



🔀 Richtek Bridgeboard Utilitie	es - InstallShield Wizard X
<u>ح</u>	Welcome to the InstallShield Wizard for Richtek Bridgeboard Utilities
	The InstallShield(R) Wizard will install Richtek Bridgeboard Utilities on your computer. To continue, click Next.
	WARNING: This program is protected by copyright law and international treaties.
	< Back Next > Cancel

Figure 9. Driver Installation Step 5

🕷 Richtek Bridgeboard Utilities - Insta	IIShield Wizarc		>	<
License Agreement Please read the following license agreeme	ent carefully.		と	
END-USER LICENSE AGREEN IMPORTANT-READ CAREFULLY: ("Agreement") is a legal contract be (b) a business organization ("you") the Richtek Technology Corporatior materials and electronic documenta "Licensor" means Richtek Technolo	IENT - Richtel This End-User tween you (eit and Licensor (n, including any tion (the "Softw gy Corporation	Bridgeboard License Agreer her (a) an indivic (as designated b y associated med vare"). As used I 1.	I Utilities	
WARNING: This computer program international treaties. Unauthorized	is protected b duplication or	y copyright law a distribution of thi	and s program, ⊸	,
I accept the terms in the license agreement	nt		Print	
○ I do not accept the terms in the license agreement				_
InstallShield	< Back	Next >	Cancel	

Figure 10. Driver Installation Step 6



Richtek Bridgeboard Utilities - Inst	allShield Wizard		\times
Customer Information			4.
Please enter your information.			0
<u>U</u> ser Name:			
user			
Organization:			
richtek			
e Nel - I I			
InstallShield			
	< Back	Next >	Cancel

Figure 11. Driver Installation Step 7

In Figure 12, you can set the path for the installation. Once you have set it, you can click the "OK" button. Figure 13 is a confirmation step to ensure the installation path is correct. If everything is satisfactory, you can click the "Next" button to proceed with the rest of the installation.

Kichtek Bridgeboard Utilities - InstallShield Wizard		
Browse to the destination folder.		2
Look in:		
Richtek Bridgeboard Utilities	\sim	E
Eolder name:		
D:\Program Files (x86)\Richtek Technology Corporation\Richtek Bridgeboar	rd Utilitie	s\

Figure 12. Driver Installation Step 8



😭 Richtek	Bridgeboard Utilities - InstallShield Wizard	\times
Destination Click Nex	on Folder xt to install to this folder, or click Change to install to a different folder.	と
Ð	Install Richtek Bridgeboard Utilities to: D:\Program Files (x86)\Richtek Technology Corporation\Richtek Bridgeboard Utilities\	Change
InstallShield -	< Back Next >	Cancel

Figure 13. Driver Installation Step 9

As shown in Figure 14, after confirming that all information is correct, click the "Install" button and wait for the installation progress bar to complete, as depicted in Figure 15. Once the installation is fully completed, click "Finish" to complete the entire driver installation process, as shown in Figure 16.

🕷 Richtek Bridgeboard Utilities - Insta	IIShield Wizard		\times
Ready to Install the Program The wizard is ready to begin installation.			と
If you want to review or change any of yo the wizard.	ur installation settir	igs, click Back. Click	Cancel to exit
Current Settings:			
Setup Type:			
Typical			
Destination Folder:			
D:\Program Files (x86)\Richtek Tech	nology Corporation	Richtek Bridgeboard	Utilities\
User Information:			
Name: user			
Company: richtek			
InstallShield			
	< Back	Install	Cancel

Figure 14. Driver Installation Step 10



RTQ6059GJ8 Evaluation Board

滑 Richtek E	Bridgeboard Utilities - Insta		-		Х	
Installing I	Richtek Bridgeboard Utilities				4	
The prog	ram features you selected are be					
1 1	Please wait while the InstallSh This may take several minutes	ield Wizard installs	Richtek Bridge	board	Utilities.	
	Status:					
	Copying new files					
InstallShield –				_		
		< Back	Next >		Can	cel

Figure 15. Driver Installation Step 11



Figure 16. Driver Installation Step 12



RTQ6059 Evaluation Board Software Setup

The GUI for the RTQ6059 can be downloaded from the official website. After downloading, please unzip the file and click the installer to proceed with the installation. Figure 17 demonstrates the installation process.

RTQ6059 CSOP GUI_Setup	_		×
Welcome to the RTQ6059 CSOP GUI_Setup Setup Wizard)		
The installer will guide you through the steps required to install RTQ6059 C computer.	SOP G	UI_Setup	on your
WARNING: This computer program is protected by copyright law and inter Unauthorized duplication or distribution of this program, or any portion of it, or criminal penalties, and will be prosecuted to the maximum extent possible	nationa may res e under	l treaties. sult in sev the law.	ere civil
< Back Next >		Ca	ncel

Figure 17. GUI Installation Step 1

During the installation process, set the installation path according to the user's needs, and then continue with the installation until the software is completely installed, after which the GUI can be used. Figure 18 shows the progress bar of the installation process.

RTQ6059 CSOP GUI_Setup		_		×
Installing RTQ6059 CSOP GUI	_Setup			5
RTQ6059 CSOP GUI_Setup is being installed.				
Please wait				
< Ba	ick Ne:	kt >	Car	ncel

Figure 18. GUI Installation Step 2



Graphical User Interface Overview

The RTQ6059 Evaluation Board includes the RTQ6059 CSOP GUI, which allows users to control the RTQ6059. Figure 19 displays the GUI interface, which is user-friendly.

🕸 RTQ6059 CSOP GUI	_		×
Math Overflow Conversion Ready Configuration Graph Register Configure Operation Bus Voltage Range PGA Range	1 Slave Address	ad STATU : 0x40 resh	s ~
32V FSR ±320 mV Operating Mode Shunt and bus, continuous 3 Conversion Time Bus Conversion Shunt Conversion 532 μs 532 μs 1 Max Current 0.1 1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 1 1			
	S CI	lear	~
Shunt Voltage Bus Voltage Current Power Single O -0.01mV Image: Current O OW Single Ver: 1.00 Status: I2C Read Success! Single Single	e Read Auto	Read	3

Figure 19. RTQ6059 Graphical User Interface

Quick Operation of the RTQ6059 EVB Software

- Step 1. Check Slave Address.
- Step 2. Set Configure Operation Mode.
- Step 3. Set Conversion Time.
- Step 4. Set the shunt resistor value.
- Step 5. Set Max expected current for sensing.
- Step 6. Set min current resolution for current LSB.
- Step 7. Push "Apply" bottom, the 0x05 Calibration register is written into a value for expected current LSB.
- Step 8. The data of single read or continued read selection.



Selection of Slave Address

Slave Address is follow Figure 20. Users can connect multiple EVBs and upon clicking the "Refresh" button, the GUI will detect all connected slave addresses.

RTQ6059 CSOP GUI	-		×
Math Overflow Conversion Ready E	R	ead STAT	US
Configure Operation Bus Voltage Range PGARange 32V FSR ±320 mV Operating Mode Max Current Shunt and bus, continuous A Conversion Time Calibration Register Bus Conversion Shunt Conversion 532 µs 532 µs	Slave Address	0x40 0x40 0x40	
Shunt Voltage Bus Voltage Current Power	gle Read Auto	Clear	

Figure 20. Select Slave Address

Customize the Configuration Operation

This GUI provides configuration options for operations such as setting the Bus Voltage Range, PGA Range, and Operating Mode, as illustrated in Figure 21. Users can decide on all the modes to be set based on their own needs.





Figure 21. Configure Operation

Conversion Time Settings

Users can customize the required conversion times as shown in Figure 22. Both Bus and Shunt settings are configured independently. To observe differences, selecting longer conversion times is advisable.

Conversion Time		Convers	Conversion Time			
Bus Conversion Shun 1.06 ms 84 us	t Conversion µs	Bus Conversion	Shunt Conversion 532 µs v	Bus Conver 1.06 ms	rsion ~	Shunt Conversion 532 µs ~ 84 µs
148 µs 276 µs 532 µs 1.06 ms 2.13 ms 4.26 ms 8.51 ms 17.02 ms 34.05 ms 68.10 ms						148 µs 276 µs 532 µs 1.06 ms 2.13 ms 4.26 ms 8.51 ms 17.02 ms 34.05 ms 68.10 ms

Figure22. Bus/Shunt Conversion Time Settings

Auto Calibration Function

Users need to correctly configure the compensation values in the Configuration Register to ensure accurate readings are displayed in the software. Setting the correct compensation values requires the following Equation 1, which can be cumbersome for users. Therefore, the GUI provides an automatic compensation calculation method. As shown in Figure 23, by entering the resistance value used, the maximum current, and the minimum current LSB, the final required compensation value can be calculated.

Calbration Setting (dec) = $\frac{0.04096}{R_{SHUNT} \times I_{LSB}}$ (1)



System Co	System Configuration							
Rshunt 0.1 Ω	Max Current							
Calibration Register								
Current LSB Ca	libration Register 19A Hex							

Figure 23. Auto Calibration

Function for Drawing Chart

Figure 24 displays the process when the "Auto Read" button is pressed, depicting the wait for the GUI to capture data. Figure 25 shows that users can select the desired ranges to plot and check them, with the results being immediately displayed on the Graph.

🚯 RTQ6059 CSOP G	IUI			- 🗆 ×
Math Overflow	Conversion	n Ready 📕		Read STATUS
Configuration Grap	h Register			Slave Address : 0x40 ~
				-下午 03:53:23
	Getting data			
				Clear 1
Shunt Voltage 0.03mV 	Bus Voltage	Current	Power	Simple Rend
Ver: 1.01 Status: I	2C Read Success!			

Figure 24. Data Visualization Function



🔯 RTQ6059 CSOP GUI	15-01	
Math Overflow Conversion Ready	Re	ad STATUS
Configuration Graph Register	Slave Address :	0x40 ×
Bus Voltage(V)		OATO I
3.328	📿 Refr	resh
3.326		
3.324	- F+ 03:53:23	^
3.322		
3.318		
3.316		
3.314		
3.31		
3.308		
3.306		
3.304		
-5 0 5 10 15		
Time(s)		
Shunt Voltage Bus Voltage Current Power 0 0.02mV Image: Current in the second seco	Stop I	Read
Ver: 1.01 Status: I2C Read Success!		

Figure 25. Customize Chart Display Function

Single Register Read/Write

Figure 26 demonstrates the capability to read and write to individual registers through the GUI. Step 1. Select the register to Read/Write.

🤹 F	RTQ6059 CSOP GI	IL					_		\times
	Math Overflow	Convers	ion Ready	—			Rea	id STATI	JS
Col	nfiguration Graph	Register							
Г	Addr	Name	Status	Data (Hex)			Slave Address :	0x40	~
	00	Configuration	R/W	399F			🤣 Refr	esh	
	01	Shunt Voltage	R	0002					
	02	Bus Voltage	R	19DA					^
	03	Power	R	0000					
	04	Current	R	0000	-				
	05	Calibration	R/W	019A	Reset				
L	b15 b14 1	b13 b12 1 \$\vert\$ 1 \$\vert\$ b5 b4 1 \$\vert\$ 1 \$\vert\$	b11 b10 1 € 1 b3 b2 1 € 1	0 b9 b8	Read				
	Shunt Voltage 0.02mV	Bus Voltage		turrent	Power 0W	Single R	Cle	ear Read	
Ver:	1.00 Status: 12	C Read Success!							

Figure 26. Register Read/Write Function



Bill of Materials

V _{IN} = 12V, V _S = 3.3V, I _{OUT} = 0.5A									
Reference	Count	Part Number	Value	Description	Package	Manufacturer			
U1	1	RTQ6059GJ8		16-Bit ADC Op Amp	TSOT-23-8	RICHTEK			
C1, C5	2	GRM188R71H104KA93D	0.1µF	Capacitor, Ceramic, 50V/X7R	0603	MURATA			
R1, R2	2	RAT030000FTP	0	Resistor	0603	RALEC			
RSEN1	1	RTT25R100FTE	0.1	Resistor	2512	RALEC			



Typical Applications

EVB Schematic Diagram



- 1. The capacitance values of the input and output capacitors will influence the input and output voltage ripple.
- 2. MLCC capacitors have degrading capacitance at DC bias voltage, and especially smaller size MLCC capacitors will have much lower capacitance.

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Measurement Results



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Evaluation Board Layout

Figure 27 and Figure 28 are RTQ6059GJ8 Evaluation Board layout. This board size is 50mm x 33.5mm and is constructed on two-layer PCB, outer layers with 2 oz. Cu and inner layers with 1 oz. Cu.



Figure 27. Top View



Figure 28. Bottom View



More Information

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

Important Notice for Richtek Evaluation Board

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