

RT1025 ECG/PPG AFE Cardioid Evaluation Board

Purpose

The RT1025 is an integrated AFE solution for Heart-Rate monitoring and Biopotential measurements. The RT1025 integrates low noise voltage and current sensing channels and is capable of sensing ECG (Electrocardiography) and PPG (Photoplethysmography) simultaneously. Richtek Technology developed an evaluation board with Android APP to evaluate the RT1025 performance. This document describes the operation manual of the RT1025 evaluation board. It includes the schematic, hardware and bench measure procedure.

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Introduction

General Product Information

The RT1025 is an integrated AFE solution for Heart-Rate monitoring and measurements. The RT1025 integrates low noise voltage and current sensing channels and is capable of sensing ECG (Electrocardiography) and PPG (Photoplethysmography) simultaneously. The RT1025 has > 100dB dynamic range and can sense pulses accurately by detecting the heart's electric signals. The sampling rates of the high-precision voltage and current sensing channels in the RT1025 are configurable between 64 to 4kHz. The RT1025 solution need only few discrete components and is easy to use for low-power medical ECG/PPG, sports, and fitness applications. With high levels of integration and high-precision voltage and current sensing channels, the RT1025 solution is suitable for scalable medical instrumentation systems. The RT1025 is available in a 3.1mm x 3.4mm, 41-Ball, 0.4mm pitch, WL-CSP package.

The Cardioid evaluation board (Cardioid Pad) was developed full function Android APP to evaluate the RT1025 performance. The evaluation board includes the RT1025 together with the BLE SiP and PPG modules to quickly evaluate the operation and performance of the RT1025. The detail schematic, hardware and bench measure procedure will be described in the following section. The evaluation board number is PCB106_V1 and the dimensions are 9cm x 5cm.

Product Feature

- **Evaluation Board Features**
 - ▶ Evaluation Board Number : PCB106_V1
 - ▶ Dimension : 9cm x 5cm
- **ECG Channel Feature**
 - ▶ 3 PCB ECG Electrodes
 - ▶ Ear phone Jack for 3 ECG Electrodes
 - ▶ Low Input-Referred Noise : 0.67 μ Vrms (64Hz ODR, Gain = 12)
 - ▶ Dynamic Range : 110dB at Gain = 6
 - ▶ CMRR > 85dB at 60Hz
 - ▶ Data rate : 64SPS to 4k SPS
- **PPG Channel Features**
 - ▶ G/Red/IR LED with PD Module
 - ▶ Boost Supply for Green LED
 - ▶ TX LED Current Range : 10 / 25 / 35 / 50 / 65 / 75 / 90 / 105mA, Each with 8-bit Current Resolution
 - ▶ Input-Referred Noise : 50pArms at 5 μ A Input Current
 - ▶ CMRR > 80dB at 60Hz
 - ▶ PGA Gain : 1 to 6V/V
- **Others**
 - ▶ Connect with "Cardio EVK" Android APP
 - ▶ Programmable BLE SiP
 - ▶ I²C interface for display panel
 - ▶ USB Micro-B interface for Lithium-Ion Battery Charging
 - ▶ Operating Temperature Range : -20°C to 65°C
 - ▶ RoHS Compliant and Pb Free

Key Performance Summary Table

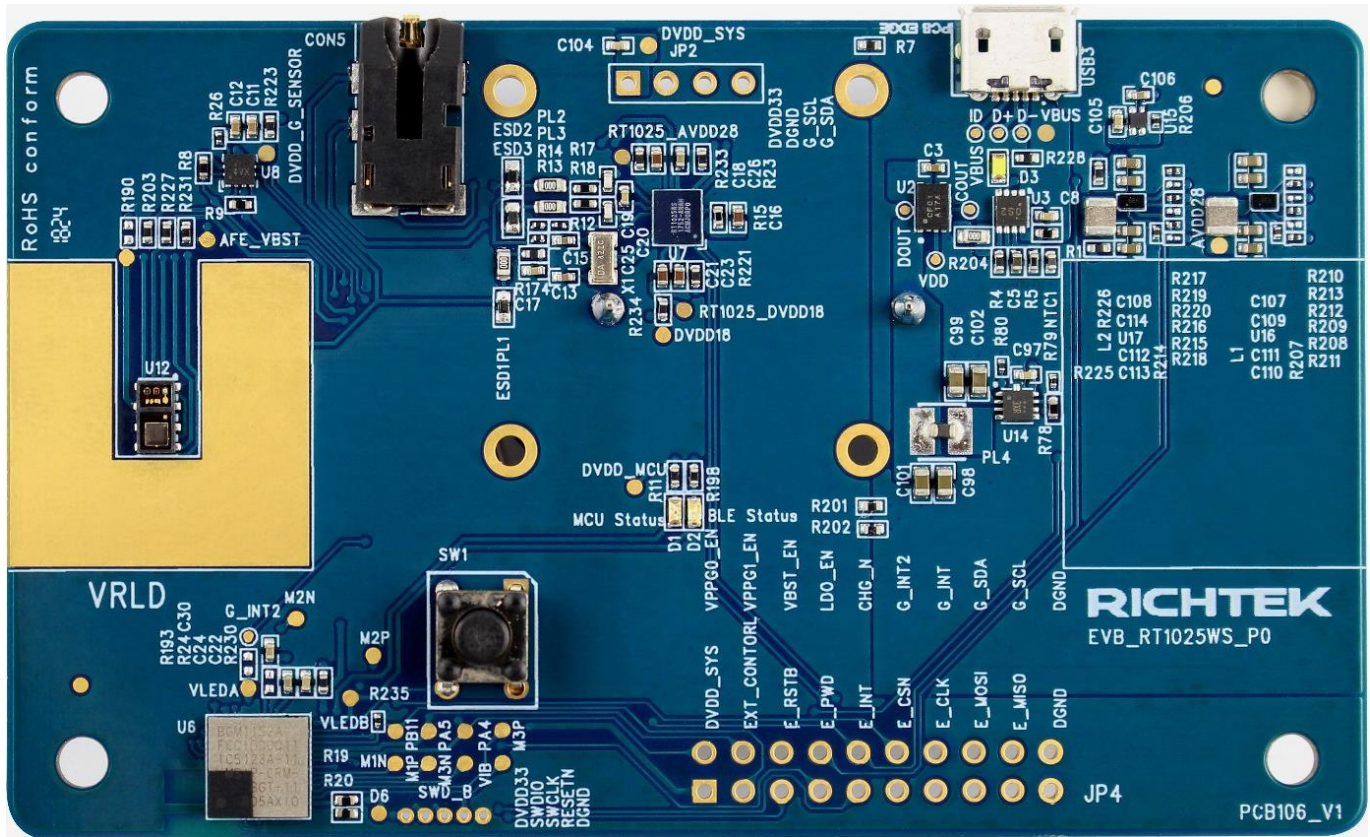
Key Features	Evaluation Board Number : PCB106_V1
PCB Battery Supply Voltage	3.6V (LIR2430)
PCB Battery Charging Voltage	5V via Micro USB connector
Current Consumption (Idle)	136 μ A
Current Consumption (BLE Advertising)	220 μ A
Current Consumption (BLE Connecting)	350 μ A
Current Consumption (Measuring)	8mA to 19mA (Depend on PPG measuring current setting)
Default Marking & Package Type	RT1025WS, WL-CSP-41B 3.10x3.48 (BS)

* Note that EVB_RT1025WS_P0 kit does not include LIR2430 battery due to transport regulations.

* LIR2430 is a rechargeable Lithium Coin Cell 3.6V, capacity 80mAh.

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 have occurred during transportation, please contact our distributors or e-mail us at evb_service@richtek.com.

Test Points

The EVB is provided with the connector interfaces and pin names listed in the table below.

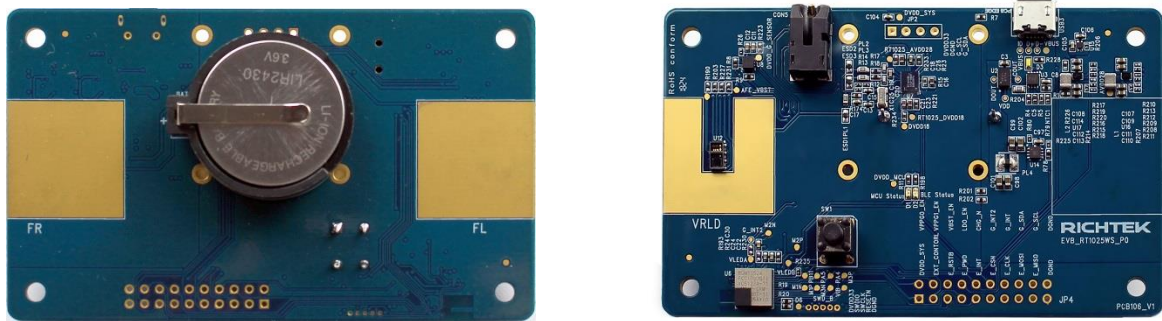
Test point/ Pin name	Signal	Comment (expected waveforms or voltage levels on test points)
VRLD	Output voltage	ECG RLD output.
FR / FL	ECG Input	Fingers contact for differential ECG input.
JP2	OLED Display Interface	(Option for display development)
JP2-1	DVDD33	Display supply voltage 3.3V.
JP2-2	DGND	Display ground.
JP2-3	G_SCL	Display I ² C data pin.
JP2-4	G_SDA	Display I ² C clock pin.
JP4	EVB Interface	Cardioid evaluation board Interface.
JP4-1	DVDD_SYS	MCU supply voltage 3.3V.

Test point/ Pin name	Signal	Comment (expected waveforms or voltage levels on test points)
JP4-2	VPPG0_EN	PPG R/IR LED select.
JP4-3	EXT_Control	Bypass MCU on EVB (High : Bypass, Floating : Default)
JP4-4	VPPG1_EN	PPG R/IR LED select.
JP4-5	E_RSTB	RT1025 ECG/PPG AFE RSTB.
JP4-6	VBST_EN	PPG Gn LED select.
JP4-7	E_PWD	RT1025 ECG/PPG AFE RWD.
JP4-8	LDO_EN	RT5707 DVDD18 enable.
JP4-9	E_INT	RT1025 ECG/PPG AFE INT.
JP4-10	CHG_N	RT9527 Charger CHG_N.
JP4-11	E_CSN	RT1025 ECG/PPG AFE SPI data pin.
JP4-12	G_INT2	RT3001 G-sensor INT2.
JP4-13	E_CLK	RT1025 ECG/PPG AFE SPI clock pin.
JP4-14	G_INT	RT3001 G-sensor INT1.
JP4-15	E_MOSI	RT1025 ECG/PPG AFE SPI serial in master out.
JP4-16	G_SDA	RT3001 G-sensor I ² C data pin.
JP4-17	E_MISO	RT1025 ECG/PPG AFE SPI serial out master in.
JP4-18	G_SCL	RT3001 G-sensor I ² C clock pin.
JP4-19	DGND	Ground.
JP4-20	DGND	Ground.
CON5	ECG Input	JACK Phone input for ECG patch.
CON5-1	VRLD_CON	ECG RLD output.
CON5-2, CON5-5	NC	No internal connection.
CON5-3	FR	ECG right signal input.
CON5-4	FL	ECG left signal input.
SWD_B	SWD debug pins	MCU SWD debug pins.
SWD_B-1	DVDD33	MCU power pin 3.3V.
SWD_B-2	SWDIO	MCU SWD IO pins.
SWD_B-3	SWCLK	MCU SWD clock pins.
SWD_B-4	RESETN	MCU SWD reset pins.
SWD_B-5	DGND	Ground.
USB3	USB Charger Interface	USB Micro-B for charger interface.
USB3-1	VBUS	RT9527 charger IC input.
USB3-2	D-	No internal connection.
USB3-3	D+	No internal connection.
USB3-4	ID	No internal connection.
USB3-5	GND	Ground.

Measurement Procedure

The RT1025 supports the reading of samples and device status upon interrupt or via polling. It contains 4kB SRAM for data buffering. The device is internally clocked to offer high-precision clock with external crystal. The flexible timing control enable the users to control the PPG device timing for different application and to power down the device for power saving. In order to achieve the high speed data acquisition, the RT1025 device was configured as a slave of SPI mode. The Cardioid evaluation board is fully assembled and tested. The usage of the evaluation board was shown in below figure.

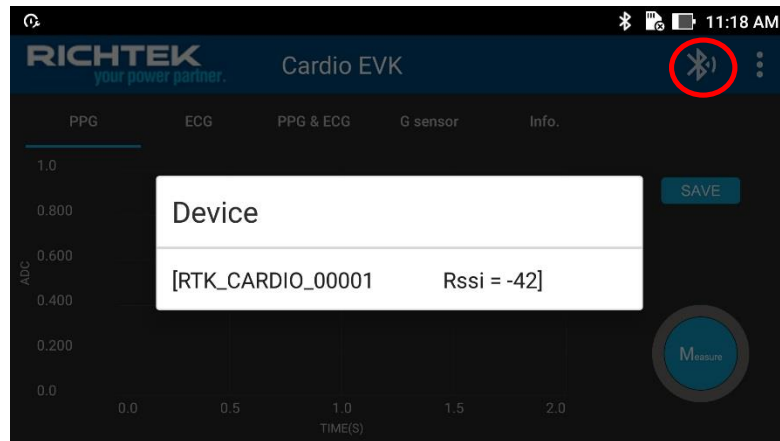
1. Insert LIR2430 Battery in the battery case. The battery can be charged by applying 5V via the Micro USB port.
 - Once on, you should see a Red LED lighting for OK status
 - If no light is present, check connections or try replacing the Battery with a fresh one.
 - If Red LED is flashing, check the I²C or SPI device correct connections.



2. Make sure the evaluation board connect to the Android APP for ECG/PPG measurement
 - Make sure Bluetooth is enabled on the phone/tablet.
 - Launch the “Cardio EVK” application on your phone/tablet.



- Then, you will need to connect to the Cardioid evaluation board Hardware. Do this by selecting the “BLE ICON” that shows up upon opening the android application. Select the evaluation board ID (RTK_CARDIO_00XXXX) from pup-out menu for BLE paring.



- After the Cardioid evaluation board BLE connection is successfully established, the “BLE ICON” will become blue and the main GUI will launch.



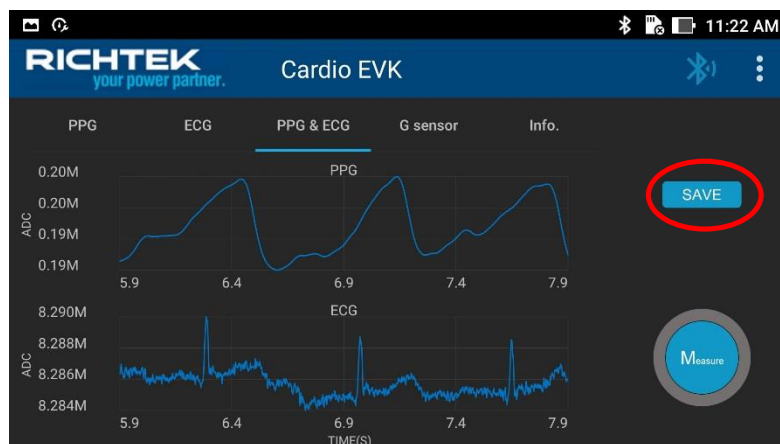
3. Put your fingers cover the VRLD and PPG sensor in the top, FR/FL in the bottom.



4. Select “PPG+ECG” tab firstly, then press “Measure” to start PPG+ECG data acquisitions. Note that it may take a while to get stable results. Press “Stop”, once you finish the measurement.



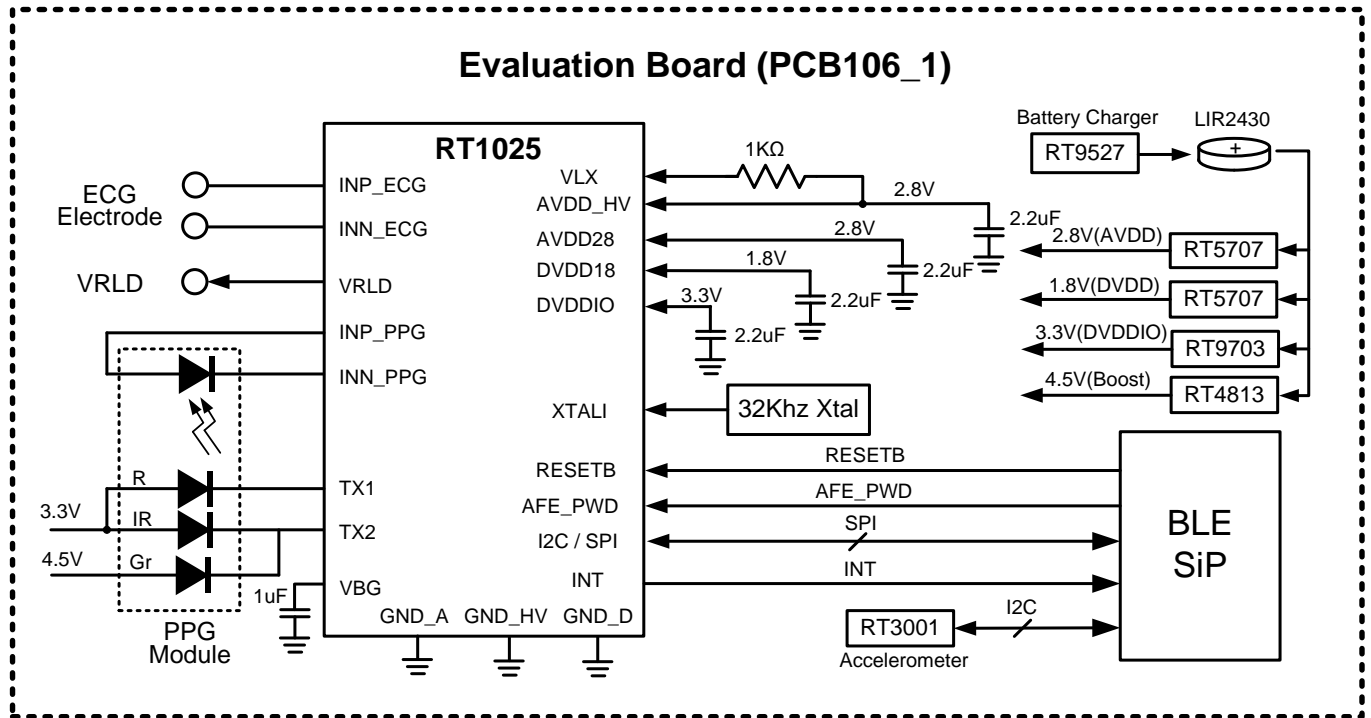
5. Check the measurement results. Press “SAVE” to store the measured data for analysis.



Please refer to the document [APP_RT1025WS_P0-00_EN](#) for more information about the Android APP.

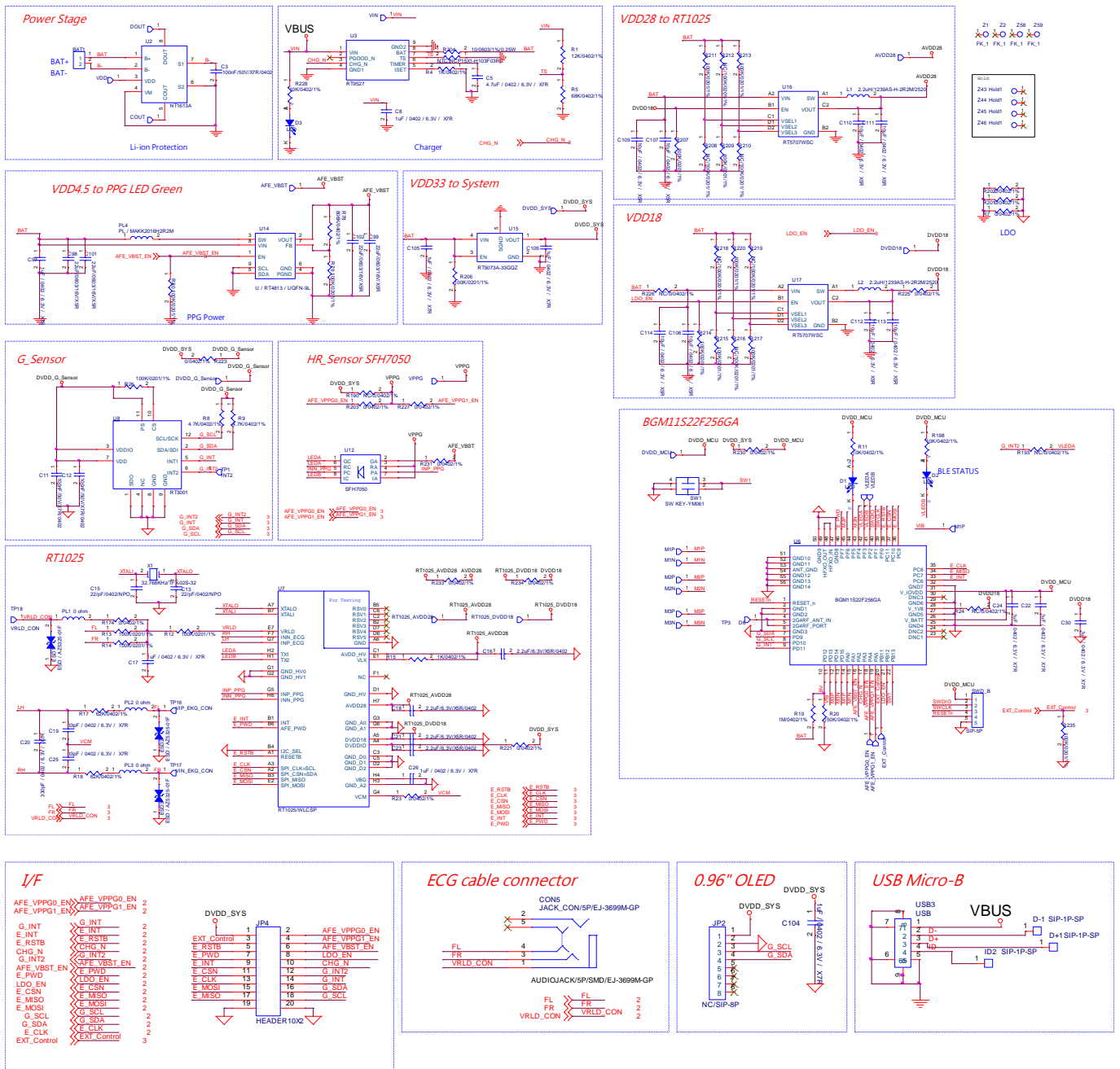
Typical Application Circuit

Using Cardioid evaluation board for ECG/PPG Sensing



Schematic, Bill of Materials & Board Layout

EVB Schematic Diagram



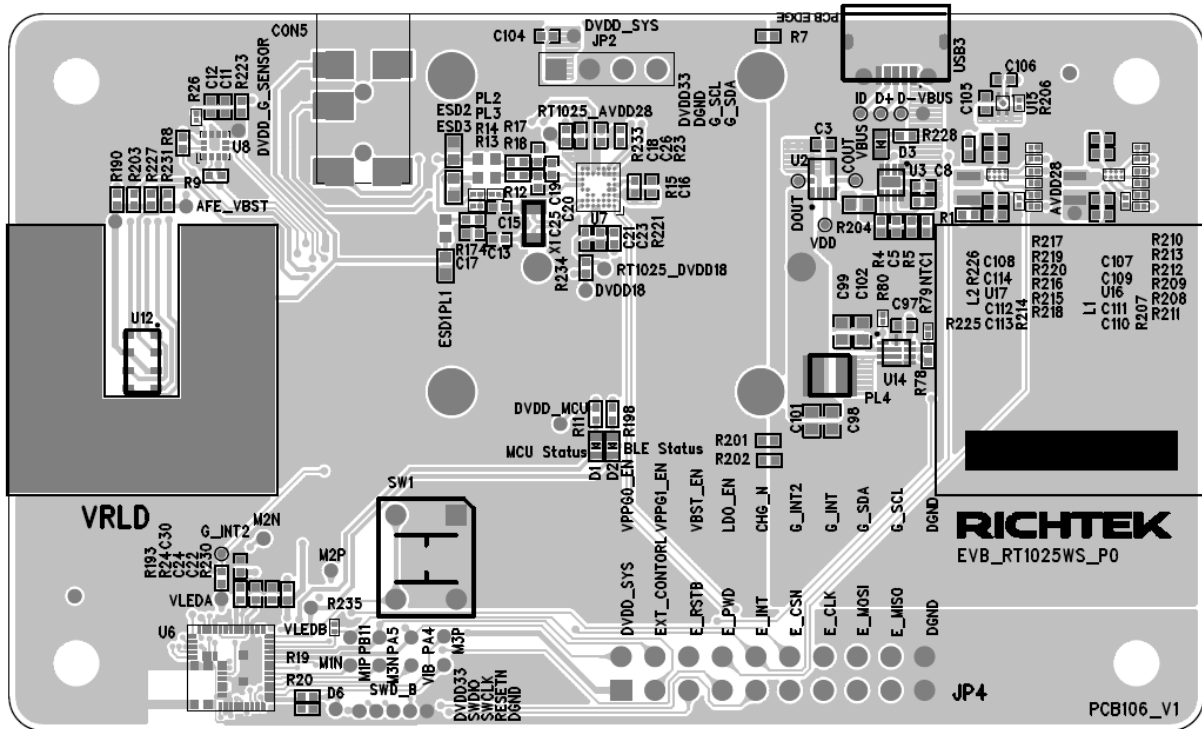
Bill of Materials

Reference	Qty	Part number	Description	Package	Manufacturer
BAT1	1	BT-BS-24-A1AJ001	SIP-2P	CR2430	HUAI YANG
CON5	1	EJ-3699M-GP	JACK_CON/5P/EJ-3699M-GP	AUDIOJACK/5P/SMD/EJ-3699M-GP	Dian Jin
C3, C11, C12	3	C1005X7R1H104K050BB	100nF/50V/X7R	C-0402	TDK
C5	1	C1005X5R1A475KT	4.7µF/6.3V/X7R	C-0402	TDK

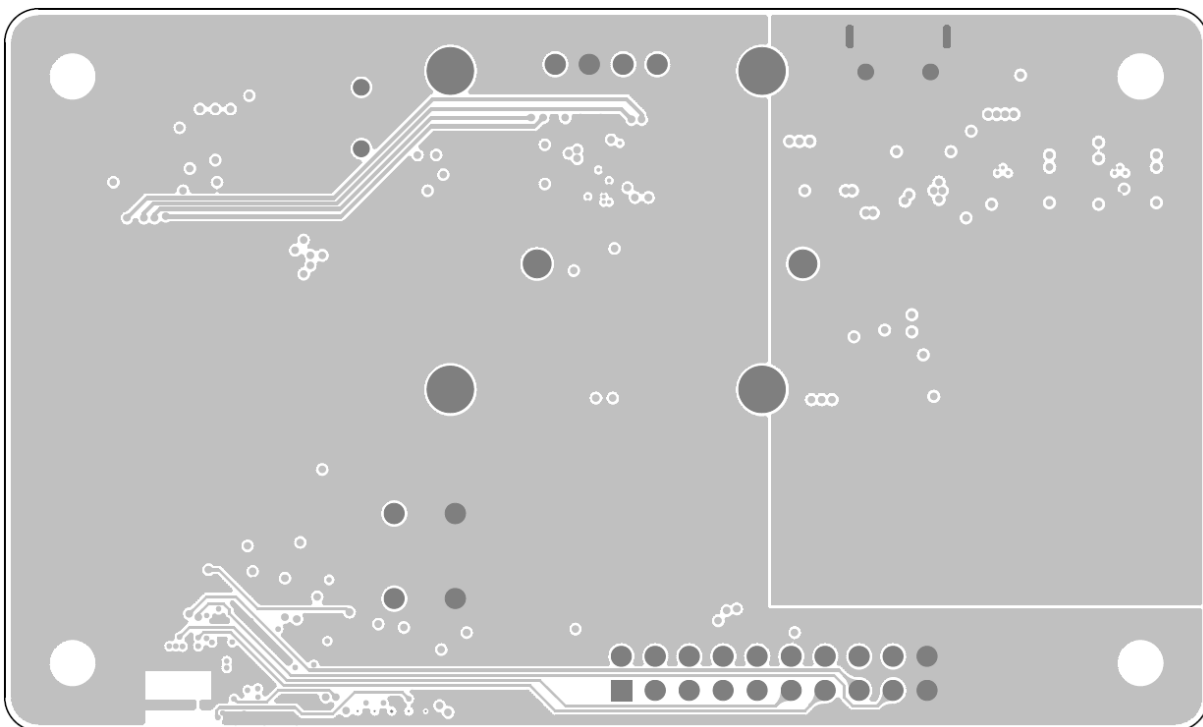
Reference	Qty	Part number	Description	Package	Manufacturer
C8, C17, C22, C24, C26, C30, C97, C104, C105, C106	10	C1005X5R0J105K050BB	1 μ F/6.3V/X5R	C-0402	TDK
C13, C15	2	GRM1555C1H220FZ01D	22pF/NPO	C-0402	Murata
C16, C18, C21, C23	4	GRM155R61E225KE11D	2.2 μ F/6.3V/X5R	C-0402	Murata
C19, C25	2	0402N330J500CT	33pF/6.3V/X7R	C-0402	WALSIN
C20	1	0402B331K100	330pF/6.3V/X7R	C-0402	WALSIN
C98, C99, C101, C102	4	GRM188R60J226MEA0D	22 μ F/6.3V/X5R	C-0603	Murata
C107, C108, C109, C110, C111, C112, C113, C114	8	0402X106M100CT	10 μ F/6.3V/X5R	C-0402	WALSIN
D1	1	LNL-191SUR	Red LED	LED_2P_RT1025	LIGH TOP
D2	1	LNL-190UB	Blue LED	LED_2P_RT1025	LIGH TOP
D3	1	LNL-190UW-4H	White LED	LED_2P_RT1025	LIGH TOP
ESD1, ESD2, ESD3	3	ESD/D5V0L1B2S9-7	ESD	R-0603	DIODES
L1, L2	2	DFE201610E-2R2M=P2	2.2 μ H/1239AS-H-2R2M/2520	L-2-5X2-0	MuRata
NTC1	1	NCP15XH103F03RC	NCP15X1-H103F03RC	R-0402	MuRata
PL1, PL2, PL3	3	WR06X000 PTL	0	L-0603	WALSIN
PL4	1	GBLM160808P-1R5M	PL/GBLM160808P-1R5M	L-NR3015	GOTREND
R1	1	CR-02FL6---12K	12k/1%	R-0402	Viking
R4, R15	2	WR04X1001FTL	1k/1%	R-0402	WALSIN
R5	1	WR04X6802FTL	68k/1%	R-0402	WALSIN
R7, R23, R174, R201, R202, R203, R221, R223, R225, R226, R227, R230, R231, R233, R234	15	WR04X000 PTL	0/1%	R-0402	WALSIN
R8, R9	2	CR-02FL6---4K7	4.7k/1%	R-0402	Viking
R11, R198, R228	3	WR04X1002FTL	10k/1%	R-0402	WALSIN
R12, R13, R14, R26, R79, R80, R206, R207, R209, R211, R213, R214, R215, R217, R220, R235	16	WR02X1003FTL	100k/1%	R-0201	WALSIN
R17, R18	2	WR04X6202FTL	62k/1%	R-0402	WALSIN

Reference	Qty	Part number	Description	Package	Manufacturer
R19	1	WR04X1004FTL	1M/1%	R-0402	WALSIN
R20	1	WR04X1503FTL	150k/1%	R-0402	WALSIN
R78	1	WR06X8063FTL	806k/1%	R-0402	WALSIN
R204	1	WR06X000 PTL	0R	R-0603	WALSIN
SW1	1	HTS 6601H	TOUCH-BTN	DIP-4P	High-Tronics
USB3	1	UMMBF-051MGCB9-CF1066	USB Micro-B Connector	USB Micro-B	Cherng Weei
U2	1	NT1613A-NQA-30-BJ	Battery Protect IC	QFN2X3_8L_0-5	Neotek
U3	1	RT9527GQW	Charger IC	WDFN-8L 2x2	Richtek
U6	1	BGM11S22F256GA	BLE SiP	BGM11S22F256GA	SiLab
U7	1	RT1025WS	ECG/PPG AFE IC	WL-CSP-41B 3.10x3.48 (BS)	Richtek
U8	1	RT3001GQL	G-sensor	LGA-12L 2x2	Richtek
U12	1	SFH7050	PPG LED & PD Module	SFH7050	OSRAM
U14	1	RT4813AGQUF	4.5V Boost IC	UQFN-9L 2x2 (FC)	Richtek
U15	1	RT9073A-33GQZ	3.3V LDO	ZQFN-4L 1x1	Richtek
U16, U17	2	RT5707WSC	1.8V/2.8V Buck IC	WL-CSP-8B 0.9x1.6 (BSC)	Richtek
X1	1	DST-310S	32.768kHz/TFX-02S-32	CRY-DST310S	HARMONY

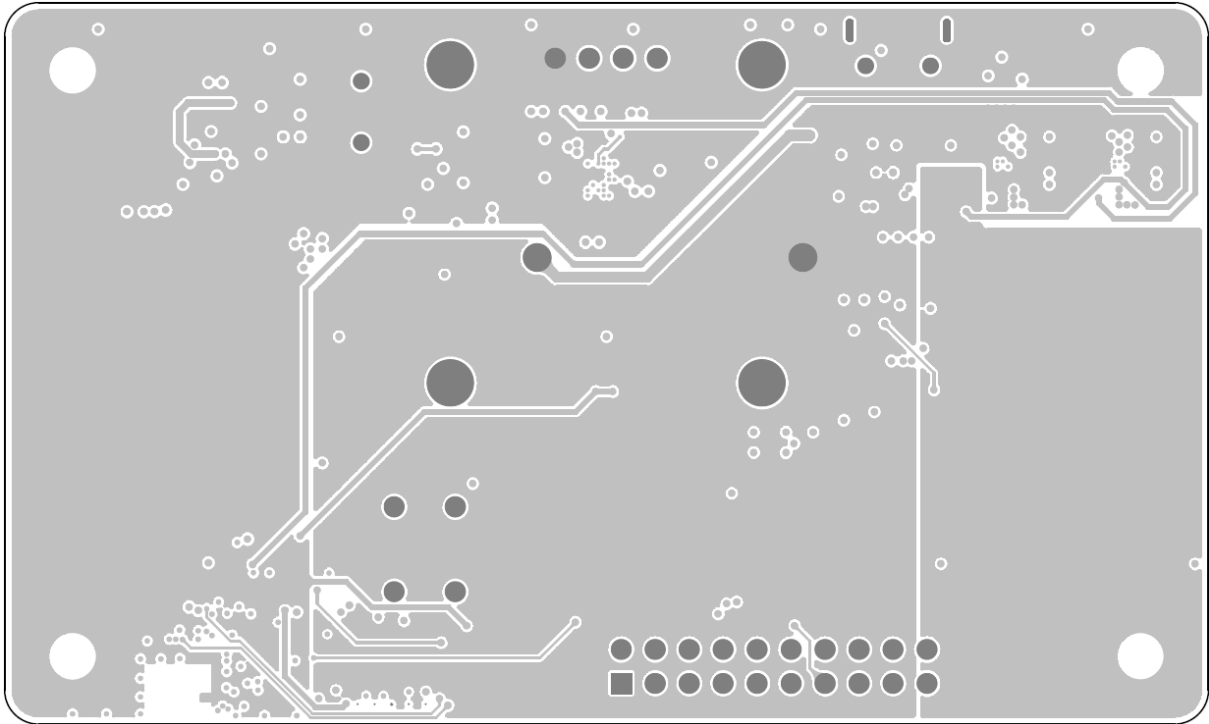
PCB Layout



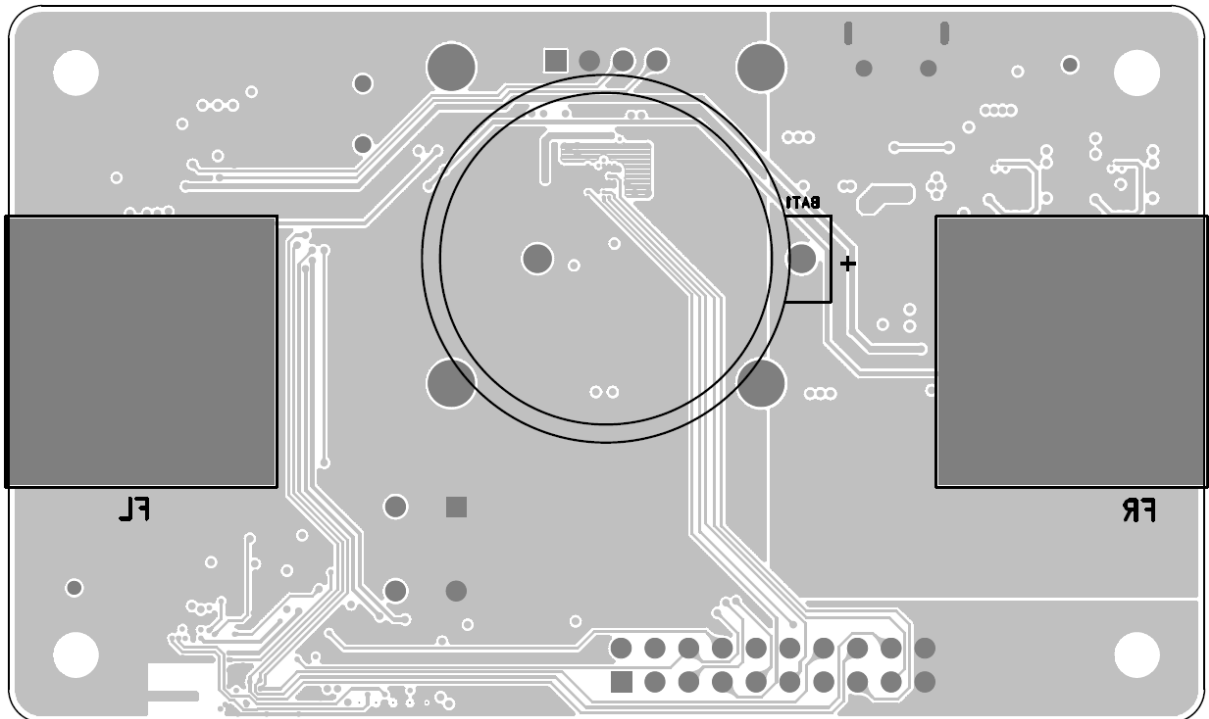
Top View (1st layer)



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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