

Easy to Use Power Bank Solution (EZPBS™) Integrated Chip with Switch Charger, MCU, ADC, and Load Switch

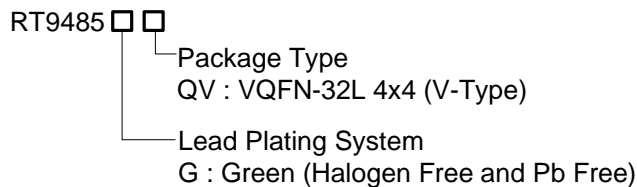
General Description

The RT9485 is a high integration and easy to use power solution for Li-ion power bank and other powered handheld applications. We call it EZPBS™ (Easy to Use Power Bank Solution). This single chip includes a Switching Charger with OTG function, MCU, Analog to Digital Converter (ADC), USBOUT Load Switch, Adapter Detection with BC1.2, DCP controller and LDO. The battery volume and the state of charging and discharging can be indicated by 4LEDs.

Applications

- Power Bank

Ordering Information

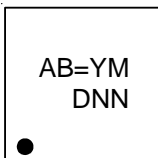


Note :

Richtek products are :

- ▶ RoHS compliant and compatible with the current requirements of IPC/JEDEC J-STD-020.
- ▶ Suitable for use in SnPb or Pb-free soldering processes.

Marking Information



AB= : Product Code
YMDNN : Date Code

Features

System

- High Accuracy Voltage/Current Regulation
 - ▶ ±1% Charge Voltage Regulation
 - ▶ ±0.1A Charge Current Regulation
 - ▶ ±3% Boost Output Voltage Regulation
- Thermal Shutdown Protection
- Reverse Leakage Protection to Prevent Battery Drainage
- Built-in USBOUT DCP Controller
- Built-in USBOUT Attach/Detach Detection
- Built-in USBOUT Light Load Detection
- Built-in Load Switch with Current Regulation Thermal Regulation and Output Short Current Protection
- Built-In Adapter Detection with BC1.2
- Built-In Accurate ADC to Measure VBAT, VBUS, TS, IBAT, USBOUT and IUSBOUT
- Built-In LDO
- OTP Based MCU
- 4 LED Driver Pin
- Button Key

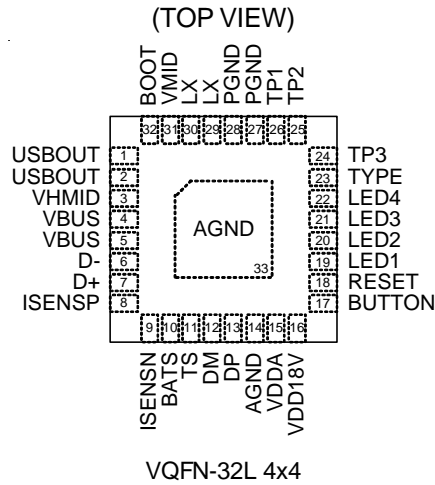
Charge Mode

- Charge Voltage Regulation
- Charge Current Regulation
- Minimum Input Voltage Regulation (MIVR)
- Average Input Current Regulation (AICR)
- Thermal Regulation
- VMID Under-Voltage Protection
- VBUS Over-Voltage Protection
- Battery Over-Voltage Protection
- Battery Temperature Protection

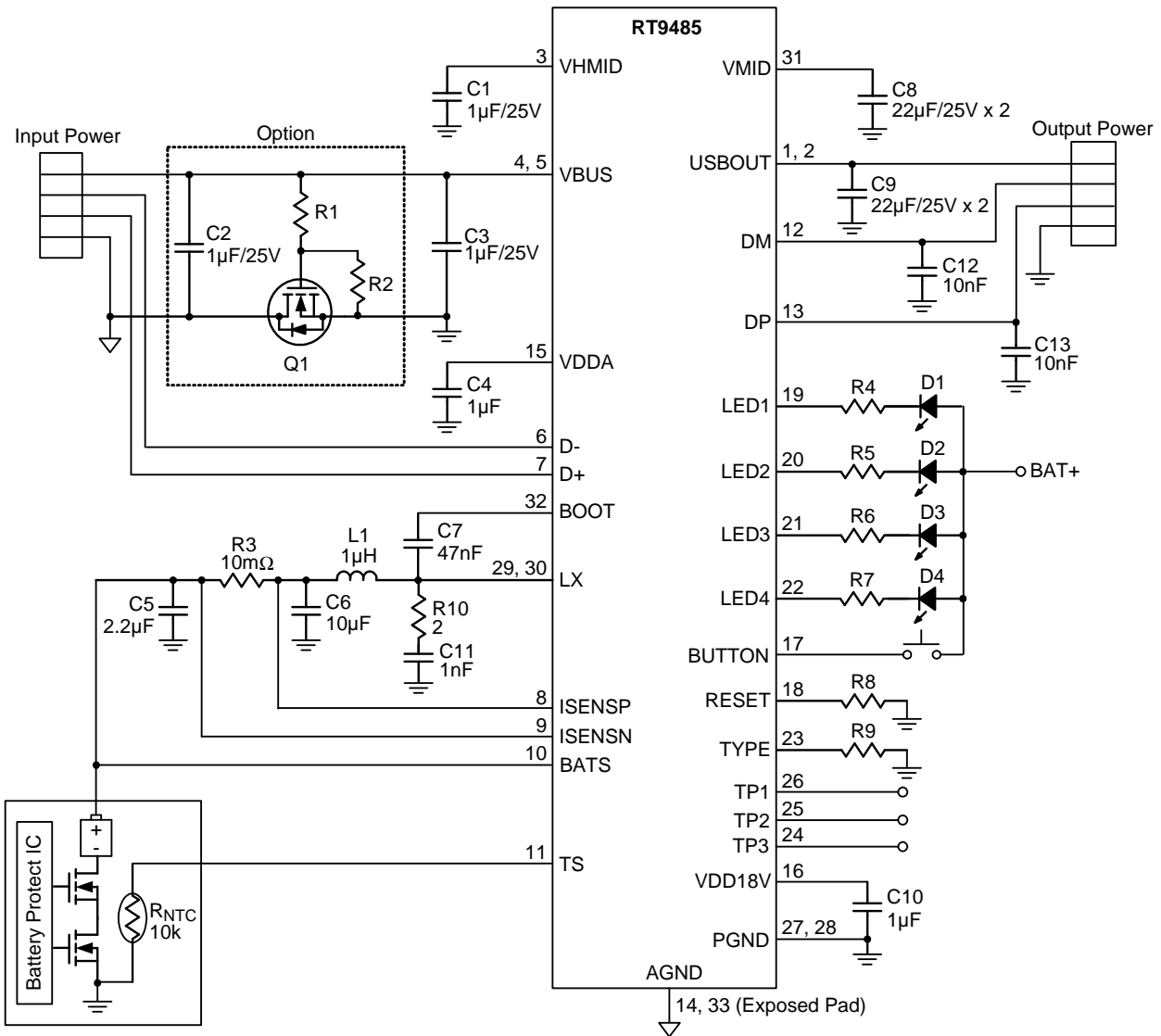
Boost Mode

- OTG Boost Current Up to 3A
- Battery Under-Voltage Protection
- VMID Over-Voltage Protection

Pin Configuration



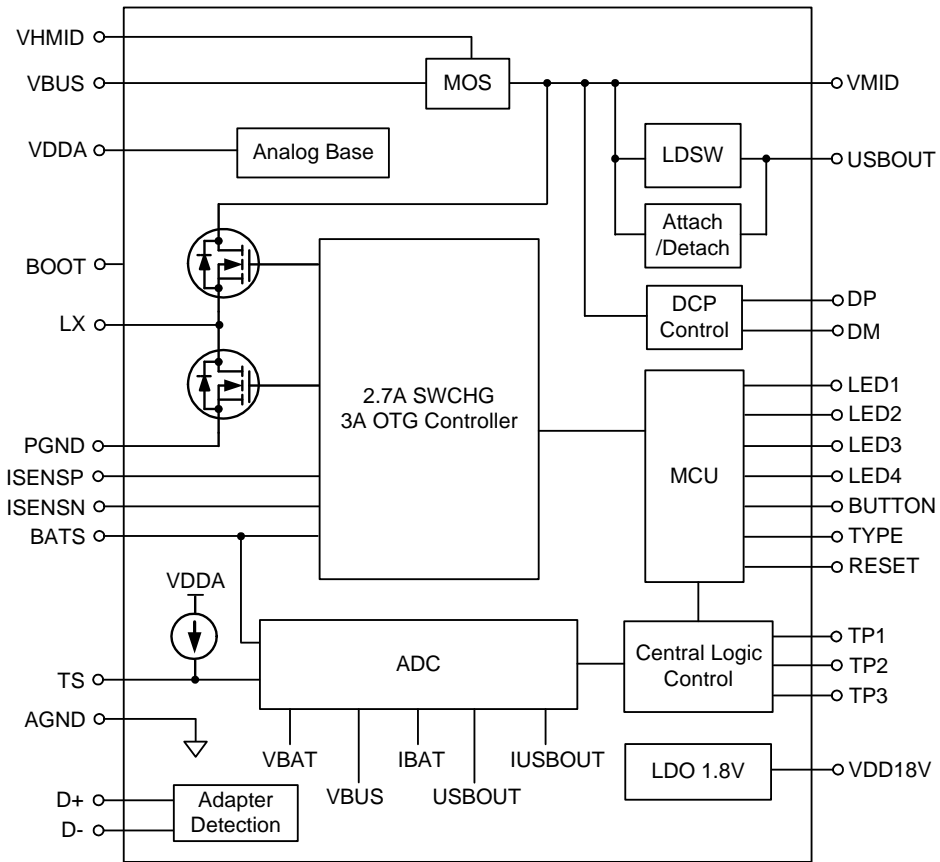
Typical Application Circuit



Functional Pin Description

Pin No.	Pin Name	Pin Function
1, 2	USBOUT	USB power output.
3	VHMID	Internal use only.
4, 5	VBUS	VBUS power supply.
6	D-	D- input for adapter detection.
7	D+	D+ input for adapter detection.
8	ISENSP	Charging current sensing positive node.
9	ISENSN	Charging current sensing negative node and connect to battery plus terminal.
10	BATS	Battery voltage sensing node.
11	TS	Battery temperature detection pin.
12	DM	DCP controller DM output.
13	DP	DCP controller DP output.
14, 33 (Exposed Pad)	AGND	Analog ground node. The exposed pad must be soldered to a large PCB and connected to AGND for maximum power dissipation.
15	VDDA	Internal power for analog blocks, put 1 μ F to GND.
16	VDD18V	External use LDO output.
17	BUTTON	Button detection pin.
18	RESET	Reset for internal use. Connect 10k Ω resistor to ground.
19	LED1	Current sink output for LED1.
20	LED2	Current sink output for LED2.
21	LED3	Current sink output for LED3.
22	LED4	Current sink output for LED4.
23	TYPE	General input pin for select battery charge voltage low is 4.2V and high is 4.35V.
24	TP3	Test pin. Keep floating. (SCL).
25	TP2	Test pin. Keep floating. (SDA).
26	TP1	Test pin. Keep floating. (INT).
27, 28	PGND	Power ground for switching charger.
29, 30	LX	Internal switch node to output inductor connection.
31	VMID	Connection point between reverse blocking and high-side.
32	BOOT	Bootstrap power node for switching charger.

Functional Block Diagram



Operation

The RT9485 is a high integrated IC for Li-Ion battery power bank. It includes a Switch charger 2.7A, a synchronous Boost 5V.

Charge Current

Base on thermal regulation function, the charging current can support up to 2.7A.

VBUS Over-Voltage Protection

If the input voltage (VBUS) is higher than the threshold voltage V_{OVP} , the internal OVP signal will go high and the charger will stop charging until VIN is below V_{OVP} - hysteresis.

VMID Over-Voltage Protection

If the internal voltage (VMID) is higher than the threshold voltage V_{OVP} , the internal OVP signal will go high and the charger will stop charging until VMID is below V_{OVP} - hysteresis.

VMID Under-Voltage Protection

If the internal voltage (VMID) is lower than the threshold voltage V_{UVP} , the internal VMID_UVP signal will go high and the system will disable LDSW function in order to protect system from short-to-ground current damages.

USBOUT SCP

The USBOUT short circuit protection (SCP) function will prevent system from burning out by monitoring the voltage drop between LDSW. If the USBOUT is short to ground, the inrush current will make the VDS voltage too large to damage chip. The SCP function also reports this condition to protect chip in time.

Boost OCP

The converter senses the current signal when the high-side P-MOSFET turns on. As a result, The OCP is cycle by-cycle current limitation. If the OCP occurs, the converter holds off the next on pulse until inductor current drops below the OCP limit.

OTP

The converter has an over-temperature protection.

When the junction temperature is higher than the thermal shutdown rising threshold, the system will be latched and the output voltage will no longer be regulated until the junction temperature drops under the falling threshold.

CC/CV/TR Multi Loop Controller

There are constant current loop, constant voltage loop and thermal regulation loop to control the charging current.

Base Circuits

Base circuits provide the internal power, VDDA and reference voltage and bias current.

Buck Regulator for Charging and Boost Regulator as BOOST

The multi-loop controller controls the operation of charging process and current supply to the system. It also controls the circuits as a Boost converter for BOOST applications.

USB Charger Detection

The RT9485 detects USB Charger (Standard Charger Port, Charging Downstream Port and Dedicated Charger Port) via D+ and D- pins.

USBOUT Attach/Detach Detection

RT9485 includes an auto attach detection for the power bank product. The attach detection has a current threshold which represent an attach condition. When the attach detection is enable, the USBOUT will generate a 1.6V to monitor the load current. Once load current is greater than $5\mu A$, the attach flag will be reported until the load current is removed.

Embedded Micro-Controller

The MCU control the power bank behavior, decide the operation mode for charging, discharging or relax. MCU also detects the button press, battery type and control LED flash function. It is use One Time Programmable (OTP) memory, the power bank function can flexible adjust for different application.

Absolute Maximum Ratings (Note 1)

- Supply Input Voltage, VBUS, VH MID ----- -0.3V to 18V
- VMID ----- -0.3V to 6.7V
- LX ----- -0.3V to 6V
- BOOT ----- -0.3V to 12V
- BOOT – LX ----- -0.3V to 6V
- VH MID – VBUS ----- -0.3V to 6V
- VH MID – VMID ----- -0.3V to 18V
- VDD18V ----- -0.3V to 3V
- Others ----- -0.3V to 6V
- Power Dissipation, P_D @ T_A = 25°C
 - VQFN-32L 4x4 ----- 3.59W
- Package Thermal Resistance (Note 2)
 - VQFN-32L 4x4, θ_{JA} ----- 27.8°C/W
 - VQFN-32L 4x4, θ_{JC} ----- 4.6°C/W
- Junction Temperature Range ----- 150°C
- Lead Temperature (Soldering, 10 sec.) ----- 260°C
- Storage Temperature Range ----- -65°C to 150°C
- ESD Susceptibility (Note 3)
 - HBM (Human Body Model) ----- 2kV

Recommended Operating Conditions (Note 4)

- Supply Input Voltage, VBAT, VBUS ----- 4.3V to 5.65V
- Junction Temperature Range ----- -40°C to 125°C
- Ambient Temperature Range ----- -40°C to 85°C

Electrical Characteristics

(V_{BUS} = 5V, V_{BAT} = 4.2V, T_A = 25°C, unless otherwise specified)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Input Power Source						
VBUS Operation Range			4	--	5.65	V
VBUS Supply Current	I _Q	PWM switching, I _{CHG} = I _{BAT} = 0mA	--	10	--	mA
		High impedance mode	--	--	200	μA
Leakage Current from Battery	I _{BAT_LEAK}	V _{BAT} = 4.2V, V _{BUS} = 0V, Charger off. 1/80 ADC execution time duty	--	50	70	μA
Protection						
VBUS OVP Threshold Voltage	V _{BUS_OVP}	VBUS rising	5.7	6	6.3	V
VBUS OVP Hysteresis	V _{BUS_OVP_HYS}	VBUS falling	--	200	--	mV

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
VBUS UVLO	V _{BUS_UVLO}	VBUS rising	3	3.25	3.5	V
VBUS UVLO Hysteresis	V _{BUS_UVLO_HYS}	VBUS falling	--	150	--	mV
I _{SENSN} OVP	V _{BAT_OVP}	V _{ISENSN} rising	103	107	114	%
I _{SENSN} OVP Hysteresis	V _{BAT_OVP_HYS}	V _{ISENSN} falling	--	5	--	%
Over-Temperature Protection	T _{OTP}	(Note 5)	--	160	--	°C
OTP Hysteresis	T _{OTP_HYS}		--	20	--	°C
Thermal Regulation Threshold	T _{REG}	(Programmable)	--	120	--	°C
Input Power Source Detection						
Poor Source Detect Threshold	V _{BUS_pr}	Bad voltage source detection	3.6	3.8	4	V
Poor Source Detect Deglitch	t _{VBUS_pr_dg}		--	30	--	ms
Poor Source Detect Hysteresis	V _{BUS_pr_hys}	VBUS rising	100	--	200	mV
Current Sink to GND	I _{VBUS_pr}	During poor source detection	--	50	--	mA
Detection Interval Time	t _{VBUS_pr_int}		--	2	--	s
Sleep Mode Comparator						
Sleep-Mode Entry Threshold VBUS - I _{SENSN}	V _{SLP}	3V < V _{ISENSN} < V _{BATREG} , VBUS Falling	--	40	100	mV
Sleep-Mode Exit Hysteresis VBUS - I _{SENSN}	V _{SLPEXIT}	3V < V _{ISENSN} < V _{BATREG} , VBUS Rising	40	120	200	mV
Sleep-Mode Deglitch Time	t _{SLP}	VBUS Rising Above V _{SLP} + V _{SLPEXIT}	--	30	--	ms
Minimum Input Voltage Regulation (MIVR)						
Minimum Input Voltage Regulation	V _{MIVR}	(Programmable)	4.2	--	4.8	V
V _{MIVR} Accuracy			-5	--	5	%
Average Input Current Regulation (AICR) Accuracy	I _{AICR_100mA}	I _{AICR} = 100mA	80	90	100	mA
	I _{AICR_500mA}	I _{AICR} = 500mA	400	450	500	
	I _{AICR_700mA}	I _{AICR} = 700mA	560	630	700	
	I _{AICR_1000mA}	I _{AICR} = 1000mA	800	900	1000	
AICR	I _{AICR}	(Programmable)	100	--	2000	mA
VDDA Regulator						
VDDA Voltage	VDDA	V _{VBUS} > 4.5V	--	4.5	--	V
		V _{VBUS} < V _{ISENSN}	--	V _{ISENSN}	--	

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
VDDA UVLO	VDDA_UV	VDDA rising	2.4	2.5	2.6	V
VDDA UVLO Hysteresis	VDDA_UV_hys	VDDA falling	--	150	--	mV
Battery Voltage Regulation						
Battery Voltage Regulation	VBATREG	(Programmable)	3.65	--	4.6	V
VBATREG Accuracy			-1	--	1	%
Re-Charge Threshold	ΔV_{REG}	VISENSN falling, $\Delta V_{REG} = (V_{BATREG} - V_{REC})$	50	125	200	mV
Re-Charge Deglitch Time	tREC		--	128	--	ms
Charging Current Regulation						
Output Charging Current	ICHG	RSENSE = 10m Ω (Programmable)	0.7	--	2.7	A
ICHG Accuracy	ICHG_ACC	RSENSE = 10m Ω	-100	--	100	mA
Pre-Charge Threshold	VPREC	Rising, (programmable)	2.3	--	3.8	V
VPREC Accuracy			-5	--	5	%
Pre-Charge Current	IPREC	(Programmable)	200	300	500	mA
IPREC Accuracy			-20	--	20	%
Charge Termination Detection						
End of Charge Current	IEOC	RSENSE = 10m Ω (Programmable)	150	--	600	mA
IEOC Accuracy		RSENSE = 10m Ω	-100	--	100	mA
Deglitch Time for EOC	tEOC	ICHG < IEOC, VISENSN > (VBATREG - ΔV_{REG}) (Programmable)	4	--	32	ms
Charger Timer Protection						
Fast-Charge Time-Out		(Programmable)	6	--	20	Hrs
Pre-Charge Time-Out		(Programmable)	30	--	60	Mins
PWM Switching Charger						
VBUS to LX Resistance	RDS(ON)_VBUS_LX	From VBUS to LX, as IAICR disable or IAICR = 2A	--	130	--	m Ω
VBUS to USBOUT Resistance	RDS(ON)_VBUS_USBOUT	From VBUS to USBOUT	--	120	--	m Ω
Low-Side On-Resistance	RDS(ON)_LS	From LX to PGND	--	40	--	m Ω
Efficiency for Charge	EFF_CHG	VBUS = 5V, VISENSN = 4V, and ICHG = 2A	--	90	--	%
Oscillator Frequency	fosc		--	0.75	--	MHz
Frequency Accuracy			-10	--	10	%

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Maximum Duty Cycle	D _{MAX}	At minimum voltage input	--	95	--	%
Minimum Duty Cycle	D _(MIN)		0	--	--	%
Peak OCP as Charger Mode			--	4.5	--	A
Boost Mode Operation						
Output Voltage Level	V _{BOOST}	To VMID (programmable)	3.625	--	5.2	V
Output Voltage Accuracy			-3	--	3	%
Output Current On VMID	I _{BST}	V _{BAT} > 3V	3	--	--	A
Efficiency for Boost	EFF _{BST}	VMID = 5V, V _{ISENSN} = 4V, and loading = 2A	--	92	--	%
Peak OCP as Boost Mode	I _{OCP_BST}		--	6	--	A
VMID OVP as Reverse Boost	V _{OVP_BST}	VMID rising	--	6	--	V
VMID OVP Hysteresis	V _{OVP_BST_HYS}	VMID falling	--	200	--	mV
Battery UVP for Boost	V _{BATMIN}	Falling, (programmable)	2.5	--	3.2	V
NTC Function						
Current Source for NTC 10kΩ	ITS_10k		33	35	37	μA
Load Switch for USBOUT						
Supply Voltage	V _{SW}		2.5	5	5.5	V
Load Switch On Resistance of MOSFET	R _{D_{S(ON)}_SW}	VMID = 5V, I _O = 1000mA	--	35	--	mΩ
Load Switch UVP Delta	V _{SW_UVP_D}	VMID – V _{USBOUT}	--	1.4	--	V
Light Load Detection Current	I _{DET}	Detection current	--	10	--	mA
Thermal Regulation Threshold of the Load Switch	T _{REG_LSW}	(Programmable)	--	100	--	°C
Adapter Detection						
D+ Voltage Source	V _{D+_SRC}		0.5	--	0.7	V
V _{DAT_REF} Voltage	V _{DAT_REF}		0.25	--	0.4	V
V _{LGC} Voltage	V _{LGC}		0.8	--	2	V
D- Sink Current	I _{DN_SINK}		50	--	150	μA
USBOUT Attach/Detach Detection						
USBOUT Attach Voltage		I _{USBOUT} = 1.5μA	1.4	1.6	1.8	V

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
USBOUT Attach/Detach Threshold		C _{USBOUT} = 40μF (Note 6)	1	5	10	μA
Detect Time 1		V _{BAT} = 3V, C _{OUT} = 30μF, 0x24[4:2] = 010	--	375	--	ms
Detect Time 2		V _{BAT} = 3V, C _{OUT} = 50μF, 0x24[4:2] = 100	--	600	--	ms
LDO 1.8V						
Output Voltage	V _{OUT_1.8V}	C _{OUT} = 1μF	1.71	1.8	1.89	V
Output Current	I _{OUT_1.8V}		10	--	--	mA
The Time for V _{OUT} Ready	t _{RDY_1.8V}	C _{OUT} = 1μF	1	--	3	ms
ADC Characteristics						
Resolution			--	12	--	Bit
Measurement Error	V _{GERR}	V _{BAT} , T _S	-10	--	10	mV
		V _{BUS} , USBOUT	-50	--	50	mV
		I _{BAT} < 1A	-100	--	100	mA
		I _{BAT} > 1A	-10	--	20	%
		I _{USBOUT} < 1A	-100	--	100	mA
		I _{USBOUT} > 1A	-10	--	10	%
Conversion Time	t _{CONV}		--	--	25	ms
Input Power						
DCP Controller Power UVLO Threshold Voltage from VMID	V _{UVLO_R_DCP_CTRL}	Rising	3.9	4.1	4.3	V
UVLO Hysteresis	V _{UVLO_F_DCP_CTRL}	Falling	100	200	300	mV
DCP Controller Supply Current	I _{DCP_CTRL}	4.5V < V _{UID} < 5V	--	150	200	μA
BC1.2 DCP Mode						
DP and DM Shorting Resistance	R _{DPM_SHORT}	V _{DP} = 0.8V, I _{DM} = 1 mA	--	157	200	Ω
Resistance between DP/DM and GND	R _{DCHG_SHORT}	DP = 0.8V	350	656	1150	kΩ
Voltage Threshold on DP1 Under which the Device goes back to Divider Mode	V _{DPL_TH_DET}	Falling	310	330	350	mV
Hysteresis	V _{DPL_TH_DET_HYS}	Rising	--	50	--	mV
DIVIDER Mode						
DP Output Voltage for DIVIDER Mode	V _{DP_2.7V}	V _{UID} = 5V	2.57	2.7	2.84	V

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit	
DM Output Voltage for DIVIDER Mode	V _{DM_2.7V}	V _{UID} = 5V	2.57	2.7	2.84	V	
DP Output Impedance for DIVIDER Mode	R _{DP_PAD1}	I _{DP} = -5μA	24	30	36	kΩ	
DM Output Impedance for DIVIDER Mode	R _{DM_PAD1}	I _{DM} = -5mA	24	30	36	kΩ	
DP and DM Shorting Resistance	R _{PM_short}		--	150	200	Ω	
1.2V / 1.2V Mode							
DP Output Voltage for 1.2V Mode	V _{DP_1.2V}		1.12	1.2	1.28	V	
DP Output Impedance for 1.2V Mode	R _{DP_PAD}		80	102	130	kΩ	
TYPE Level							
TYPE	Logic-High	V _{IH_B}		0.7 x V _{DDA}	--	--	V
	Logic-Low	V _{IL_B}		--	--	0.3 x V _{DDA}	
BUTTON Level							
BUTTON	Logic-High	V _{IH_B}		0.7 x V _{DDA}	--	--	V
	Logic-Low	V _{IL_B}		--	--	0.3 x V _{DDA}	
RESET Level							
RESET	Logic-High	V _{IH_B}		0.7 x V _{DD18V}	--	--	V
	Logic-Low	V _{IL_B}		--	--	0.3 x V _{DD18V}	
LED Output							
LED Open Drain	V _{LED}	I _{SINK} = 10mA	--	--	200	mV	

Note 1. Stresses beyond those listed “Absolute Maximum Ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions may affect device reliability.

Note 2. θ_{JA} is measured under natural convection (still air) at T_A = 25°C with the component mounted on a high effective-thermal-conductivity four-layer test board on a JEDEC 51-7 thermal measurement standard.

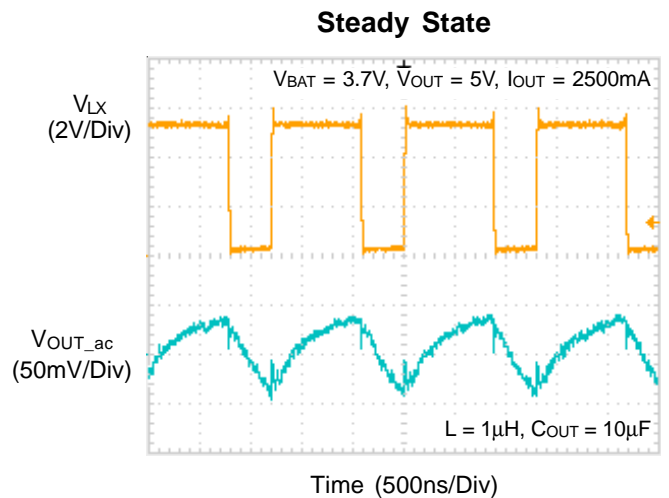
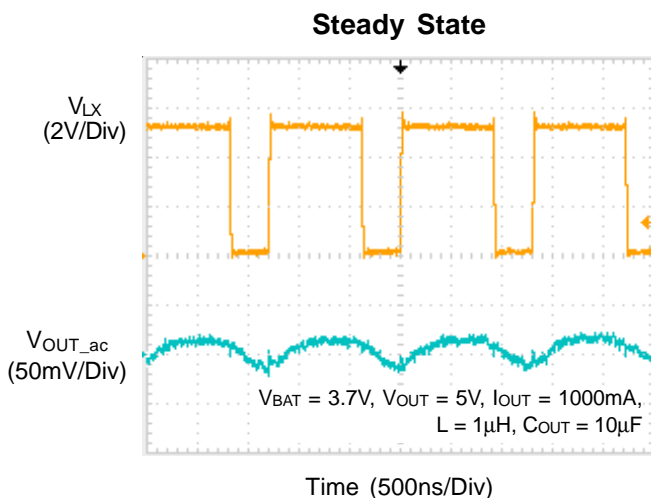
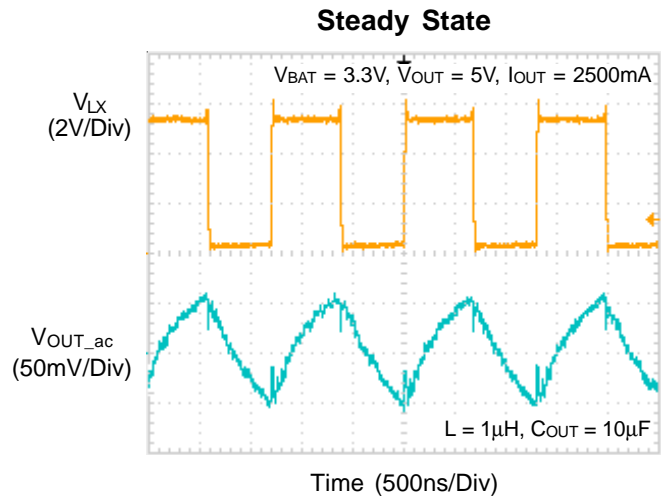
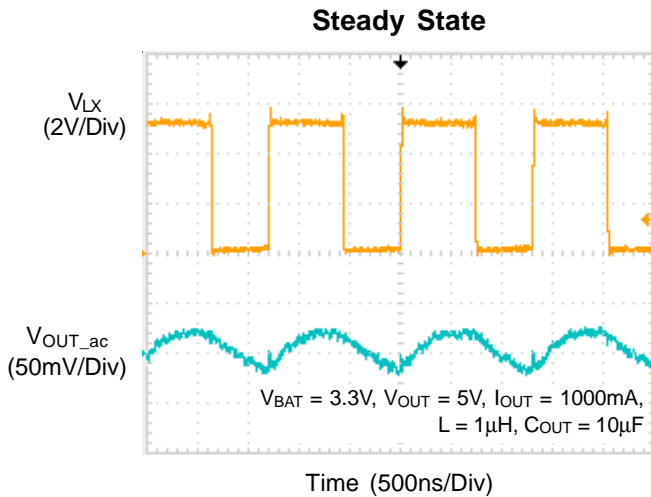
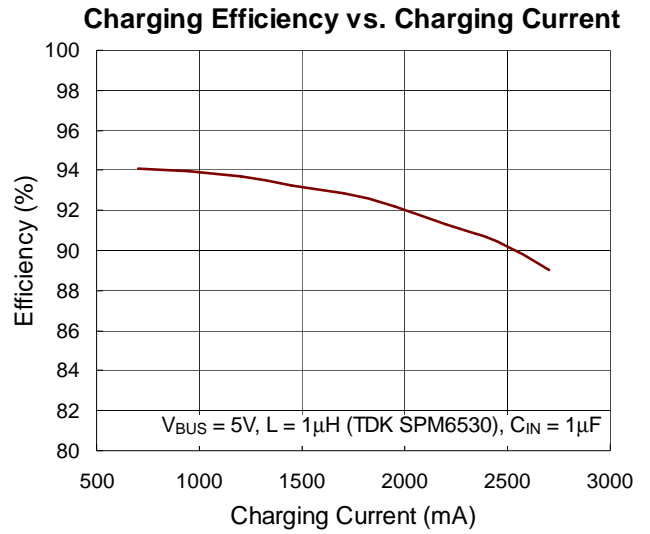
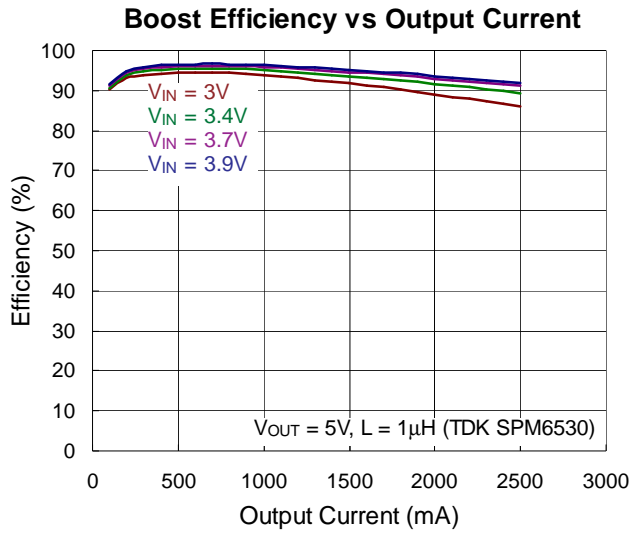
Note 3. Devices are ESD sensitive. Handling precaution is recommended.

Note 4. The device is not guaranteed to function outside its operating conditions.

Note 5. Guarantee by Design.

Note 6. It will attach when only plug-in APPLE charging line.

Typical Operating Characteristics



Application Information

MCU Functional Block Diagram

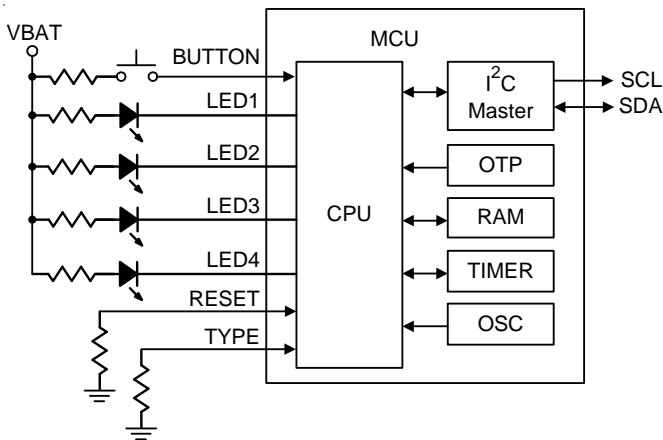


Figure 1. MCU Hardware Block Diagram

The kernel of MCU is a high performance and low power CPU, the program code is store in a One Time Programmable (OTP) memory. The MCU control the charge and discharge scenario, battery type selection, button detection, LED SOC look up and LED flash.

I²C Master

MCU is via I²C interface to control the switch charger, ADC, Adapter Detection, DCP controller and Load Switch what the IPs in the RT9485. I²C master can transport the I²C physical layer protocol byte by byte.

TYPE

The TYPE pin is use for select the 4.2V battery type or 4.35V. Battery type will be set to 4.2V when TYPE pin is pull low, otherwise battery type is set to 4.35V.

BUTTON

The button pin detects the button is press or not. It will trigger the interrupt to MCU when button pressed.

LED

There are four LED pins for LED driver. Its IO structure is open-drain. The LED flash sequence is defined by firmware program for increase the application flexibility.

TIMER

There are three types timer for firmware usage. They are RTC, TIMER and WDT respectively. The RTC and TIMER include interrupt function to trigger MCU. The WDT can reset MCU when system is crash.

Power Bank Function Overview

Operation Mode

There are four main operation modes in the power bank operation state machine. They are Power on, Relax, CHG and DCHG respectively.

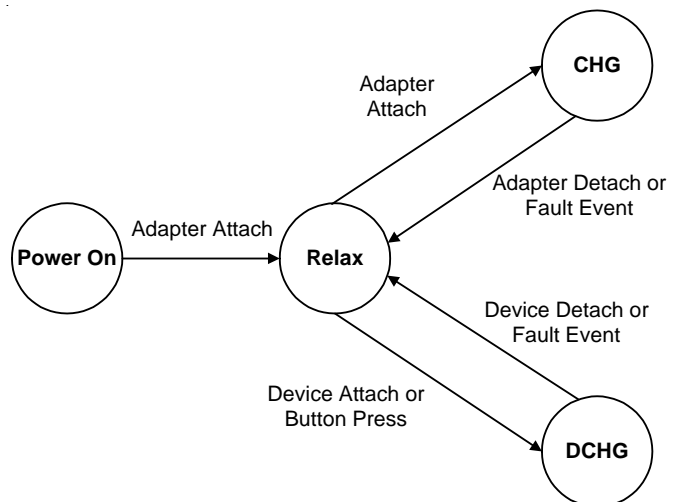


Figure 2. Power Bank Operation State Machine

Power ON

Once the RT9485 is power on, firmware will complete all initial setting and system check then keep in the power on stage. The discharge is not available when device connect to power bank before button press or adapter connection. It can prevent wrong operation during power bank assembly.

Relax

The state is enter relax mode if there is no adapter and device connect. For saving the power consumption there are only adapter and device detect function will be enabled in the relax mode. Besides, MCU will periodical wake by RTC and to monitor the whole system status.

CHG

The charge state will be started if adapter attach and battery status is suitable for charge. The basic condition to cause stop charging is the temperature of battery over the safety range 0 to 50°C.

The total sink current from adapter will follow the specification of BC1.2. JEITA is also implemented for make safe battery charging and lengthen the battery life.

The power of adapter is also bypass to USBOUT port, it can make device and battery charging at the same time.

DCHG

There are two event trigger discharge state, device attach and button press. The firmware will check the battery voltage and temperature then stop discharge when battery low or over safe temperature range -20 to 60°C. The USBOUT output over/short current is also protected.

LED SOC Look Up

Power bank LED number is judge by battery voltage and defined threshold. There are four thresholds to indicate 0%, 25%, 50%, 75% battery capacity. MCU to measure the battery voltage by ADC and look up the voltage is under which one LED level. MCU is also measure the current and temperature of battery and do the compensation. It can prevent the abnormal LED number drop or jump.

LED Flash

LED display has charge and discharge mode. The following table shows LED flash behavior for charging and discharging mode.

Table 1. LED Flash Table in The Charging Mode

Charge Mode				
SOC	LED1	LED2	LED3	LED4
0 to 25%	Flash	OFF	OFF	OFF
25 to 50%	ON	Flash	OFF	OFF
50 to 75%	ON	ON	Flash	OFF
75-Full Charge	ON	ON	ON	Flash
Full Charge	ON	ON	ON	ON

Table 2. LED Flash Table in The Discharging Mode

Discharge Mode				
SOC	LED1	LED2	LED3	LED4
Under Voltage	Flash 5sec	OFF	OFF	OFF
0 to 25%	Flash	OFF	OFF	OFF
25 to 50%	Flash	Flash	OFF	OFF
50 to 75%	Flash	Flash	Flash	OFF
75- Full Charge	Flash	Flash	Flash	Flash

Thermal Considerations

The junction temperature should never exceed the absolute maximum junction temperature $T_{J(MAX)}$, listed under Absolute Maximum Ratings, to avoid permanent damage to the device. The maximum allowable power dissipation depends on the thermal resistance of the IC package, the PCB layout, the rate of surrounding airflow, and the difference between the junction and ambient temperatures. The maximum power dissipation can be calculated using the following formula :

$$P_{D(MAX)} = (T_{J(MAX)} - T_A) / \theta_{JA}$$

where $T_{J(MAX)}$ is the maximum junction temperature, T_A is the ambient temperature, and θ_{JA} is the junction-to-ambient thermal resistance.

For continuous operation, the maximum operating junction temperature indicated under Recommended Operating Conditions is 125°C. The junction-to-ambient thermal resistance, θ_{JA} , is highly package dependent. For a VQFN-32L 4x4 package, the thermal resistance, θ_{JA} , is 27.8°C/W on a standard JEDEC 51-7 high effective-thermal-conductivity four-layer test board. The maximum power dissipation at $T_A = 25^\circ\text{C}$ can be calculated as below :

$$P_{D(MAX)} = (125^\circ\text{C} - 25^\circ\text{C}) / (27.8^\circ\text{C}/\text{W}) = 3.59\text{W for a VQFN-32L 4x4 package.}$$

The maximum power dissipation depends on the operating ambient temperature for the fixed $T_{J(MAX)}$ and the thermal resistance, θ_{JA} . The derating curves in Figure 3 allows the designer to see the effect of rising ambient temperature on the maximum power dissipation.

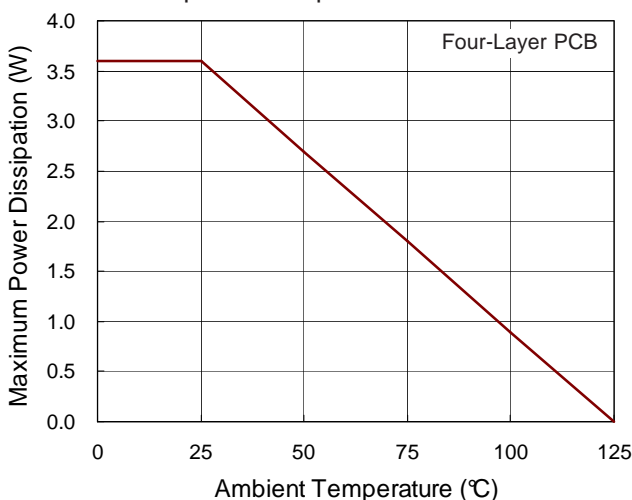


Figure 3. Derating Curve of Maximum Power Dissipation

Layout Considerations

Some PCB layout guidelines for optimal performance of RT9485 list as following. Following figure shows the real PCB layout considerations and it is based on the real component size whose unit is millimeter (mm).

- ▶ Place the input and output capacitors as close to the input and output pins as possible.
- ▶ Keep the main power traces as wide and short as possible.
- ▶ The output inductor and boot capacitor should be placed close to the chip and LX pins.
- ▶ The battery voltage sensing point should be placed after the output capacitor.
- ▶ To optimize current sense accuracy, connect the traces to RSENSE with Kelvin sense connection by ISENSEN and ISENSP.
- ▶ LX node is with high frequency voltage swing and should be kept small area. Keep analog components away from LX node to prevent stray capacitive noise pick-up.
- ▶ Add Snubber in LX : 2Ω resistor 0805 package and 1nF capacitor.

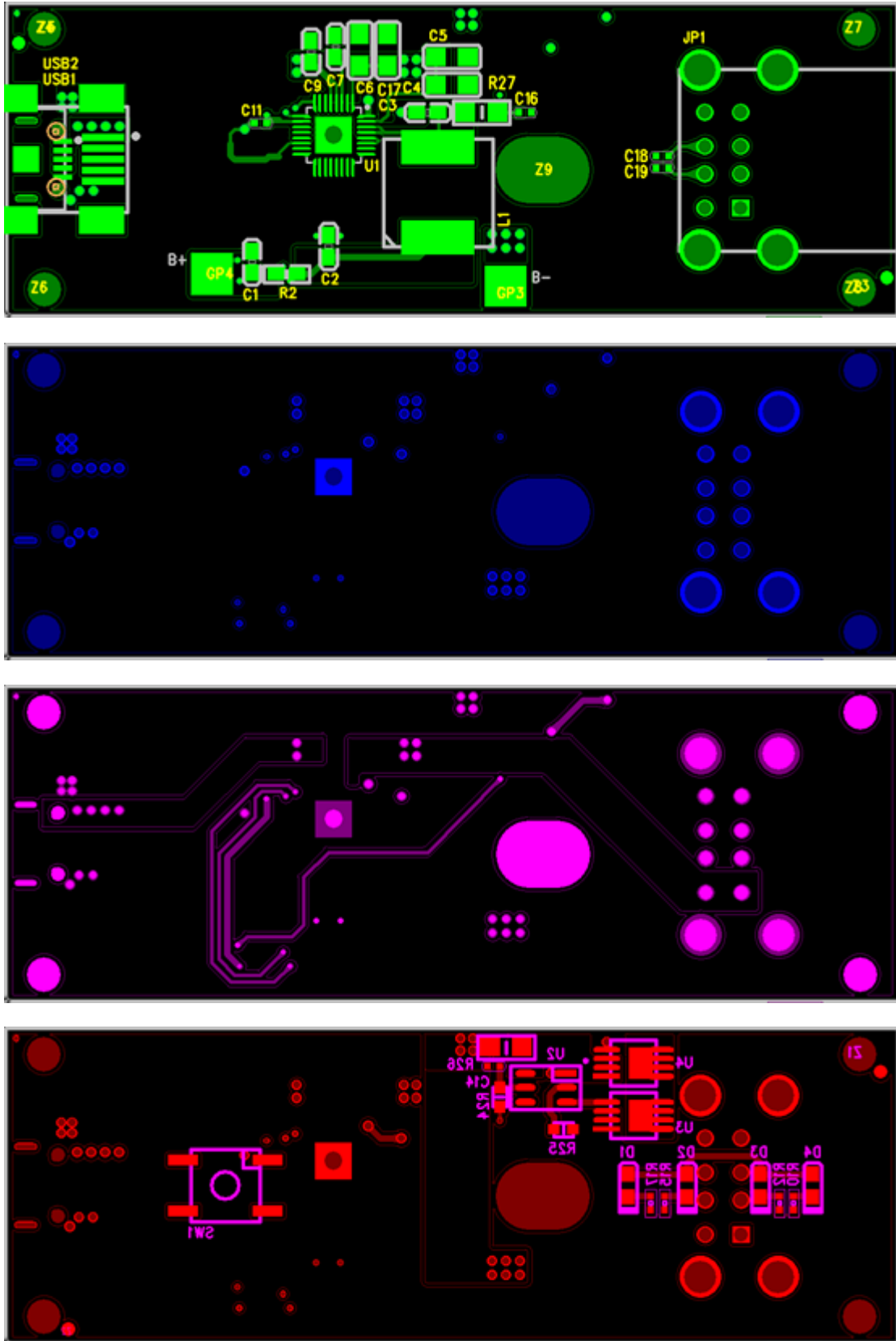
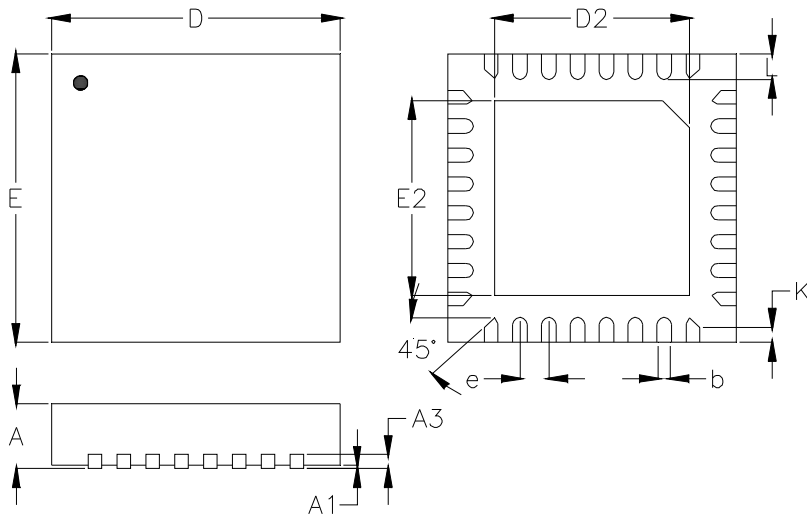


Figure 4. PCB Layout Guide

Outline Dimension



DETAIL A
Pin #1 ID and Tie Bar Mark Options

Note : The configuration of the Pin #1 identifier is optional, but must be located within the zone indicated.

Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.800	1.000	0.031	0.039
A1	0.000	0.050	0.000	0.002
A3	0.175	0.250	0.007	0.010
b	0.150	0.250	0.006	0.010
D	3.950	4.050	0.156	0.159
D2	2.650	2.750	0.104	0.108
E	3.950	4.050	0.156	0.159
E2	2.650	2.750	0.104	0.108
e	0.400		0.016	
L	0.300	0.400	0.012	0.016
K	0.200		0.008	

V-Type 32L QFN 4x4 Package

Richtek Technology Corporation

14F, No. 8, Tai Yuen 1st Street, Chupei City
Hsinchu, Taiwan, R.O.C.
Tel: (8863)5526789

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