High Performance, Constant Current LED Driver for Dual Panel Mobile Phone

General Description

The RT9272 is a high efficiency step-up DC-DC converter specifically designed for dual panel mobile phone applications.

According to SP status, RT9272 can either regulates output current flowing through series-connected LEDs for main panel or for sub panel with a common output LC filter. This along with compact VDFN-10L 3x3 package and high switching frequency allows less part count and smaller external components for space and cost saving.

Pulling low EN pin shuts down the chip and reduces the supply current to less than 1μA. The EN pin also accepts PWM signal for LED brightness dimming control. The averaged LED current is well proportional to the duty cycle of the PWM signal. The internal soft start reduces inrush current during EN turning on or PWM dimming control.

Other features include OVP, OCP and OTP. OVP prevents the damages in case of feedback loop open.

Ordering Information

RT9272 □ □

Package Type
QV : VDFN-10L 3x3 (V-Type)

Operating Temperature Range
P : Pb Free with Commercial Standard
G : Green (Halogen Free with Commercial Standard)

Note :

Richtek Pb-free and Green 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.
- 100% matte tin (Sn) plating.

Marking Information

For marking information, contact our sales representative directly or through a Richtek distributor located in your area, otherwise visit our website for detail.

Features

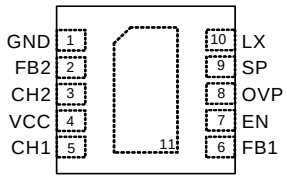
- **Low V_{IN} Operating Range : 2.7V to 4.5V**
- **Maximum Output Voltage up to 16V**
- **Small LC filter by 1.1MHz Operation Frequency**
- **Share One Set of Inductor and Schottky Diode for 2 Channels**
- **Programmable Dimming Function by EN Pin with 100Hz to 1kHz**
- **40μA Quiescent Current (Switch-Off)**
- **Internal Soft-Start Function to Avoid PWM Dimming Noise.**
- **Zero Shut Down Supply Current**
- **Complete Protection : OVP, OCP, OTP and SS**
- **RoHS Compliant and 100% Lead (Pb)-Free**

Applications

- Dual panel mobile phone, with LED backlight

Pin Configurations

(TOP VIEW)



VDFN-10L 3x3

Typical Application Circuit

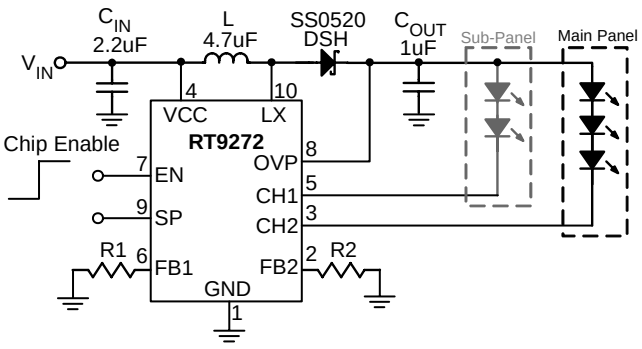


Figure 1. 2LEDs for Sub panel and 3LEDs for Main panel

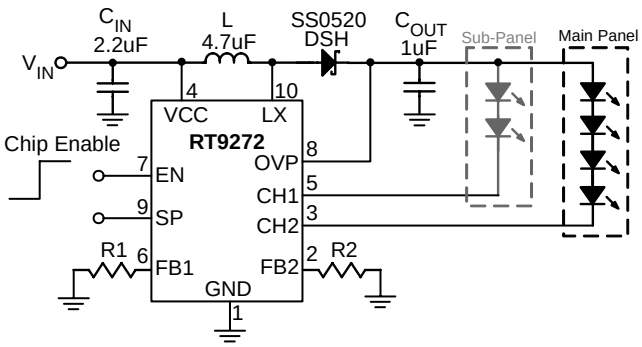


Figure 1. 2LEDs for Sub panel and 4LEDs for Main panel

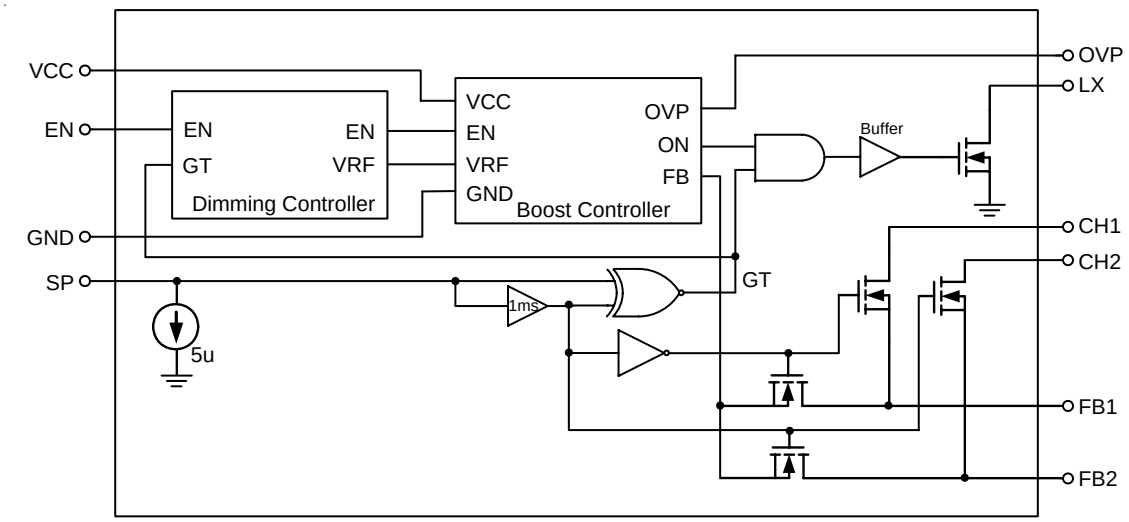
Note:

L : Measured by Murate LQH32C_53 series 4.7µH with DCR = 0.15Ω

Functional Pin Description

Pin No.	Pin Name	Pin Function
1	GND	Ground.
2	FB2	Feedback 2. Internal feedback voltage to set FB current of Ch2 as SP pin pull high.
3	CH2	Channel 2. Internal FB loop. Connect the cathode of LED to this pin.
4	VCC	Voltage Input Pin. Bypass a 2.2uF capacitor to GND to reduce the input noise.
5	CH1	Channel 1. Internal FB loop. Connect the cathode of LED to this pin.
6	FB1	Feedback 1. Internal feedback voltage to set FB current of Ch1 as SP pin pull low
7	EN	Chip Enable Pin. Pull low or floating this pin to disable the system. Using a PWM signal on CE pin can achieve the dimming control.
8	OVP	Over Voltage Protection. Detect over voltage condition and latch system until SP, EN or UVLO reset. Connect directly to the output capacitor.
9	SP	Selection Pin. Internal MOSFET selection. Pull low to turn on the internal Ch1. Pull high to turn on Ch2. As SP input signal change, internal MOSFET of LX pin will turn off 1ms to prevent the over voltage damage by the output voltage instant change.
10	LX	Switch Pin. Connect this pin to inductor and schottky diode. Minimize the track area to reduce EMI.
Exposed Pad (11)	NC	No Internal Connection.

Function Block Diagram



Operation

RT9272 operates at a wide input voltage range suitable for Li-ion battery and has a constant high frequency for smaller inductor and capacitors. The block diagram refers the operation circuit. The scheme is divided into three parts: dimming controller, boost controller and the logic selection function. By SP pin, it can choose the different channel to turn on CH1 or CH2. As the input signal change, internal MOSFET of LX pin will turn off 1ms to prevent the over voltage damage by the output voltage instant change.

The Dimming Controller:

RT9272 uses the PWM signal on EN pin to achieve dimming control. If the period of EN is less than 3ms in 50% duty, EN is always pulled high. Then EN signal is sent to the next boost controller to enable the function. This action is to differentiate between shut down and dimming control. VRF offers the reference voltage to error amplifier of next function. The internal soft start is designed for enable control and dimming control to avoid the inrush current.

The Boost Controller:

RT9272 uses current mode control scheme to provide better performance of line and load regulation. The boost controller includes of error amplifier, summing comparator, logic control and protection function. As SP switches, the channel will be changed for 2LEDs output or 3LEDs output. The difference between the feedback voltage and the reference voltage is send to the negative input of comparator. The comparator also senses the sensing current from inductor and slope compensation. To keep the output in regulation, the output of summing comparator is sent to the logic function, and then to control the duty ratio of the MOSFET switch. If the error amplifier's output increases, the duty of the switch will be larger to deliver more current to the output.

Absolute Maximum Ratings (Note 1)

- Input Supply Voltage ---------- –0.3V to 6V
- LX ---------- –0.3V to 18V
- CH1, CH2, and OVP ---------- –0.3V to 18V
- The Other Pins ---------- –0.3V to 6V
- Power Dissipation, P_D @ T_A = 25°C, T_J = 125°C
  VDFN-10L 3x3 ---------- 2.083W
- Package Thermal Resistance (Note 2)
  VDFN-10L 3x3, θ_{JA} ---------- 48°C/W
- Operating Junction Temperature Range ---------- –40°C to 85°C
- Storage Temperature Range ---------- –65°C to 150°C
- Lead Temperature (Soldering, 10 sec.) ---------- 260°C

Recommended Operating Conditions (Note 3)

- Input Supply Voltage ---------- 2.7V to 4.5V
- Output Voltage ---------- Under 16V
- Output Current ---------- Under 80mA

Electrical Characteristics

(V_{IN} = 3.7V, T_A = 25°C, Unless Otherwise specification)

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
System Supply						
Supply Current	I_{CC}	V_{CC}=3.7V, Switching, V_{FB}=0V	--	--	2	mA
Shut Down Current	I_{CC}	V_{CC}=3.7V, V_{EN}<0.4V	--	--	1	uA
Maximum Duty Cycle			85	90	--	%
Reference Voltage						
Feedback Voltage 1	V_{FB1}		0.285	0.300	0.315	V
Feedback Voltage 2	V_{FB2}		0.285	0.300	0.315	V
Power Switch MOSFET						
On Resistance of MOSFET	$R_{DS(ON)}$		--	0.5	1	Ω
Current Limitation	I_{MAX}	Normal Operation	--	1.5	--	A
Internal MOSFET Selection						
On Resistance of CH1 MOSFET	$R_{DS(ON)}$		--	6	9	Ω
On Resistance of CH2 MOSFET	$R_{DS(ON)}$		--	4.0	6	Ω
SP Low Level Voltage	V_{SP}		--	--	0.4	V
SP High Level Voltage	V_{SP}		1.5	--	--	V
SP signal change delay time	$R_{DS(ON)}$	LX off time as SP change	--	0.5	1	ms
Protection						
OVP Threshold	OVP		16	17	19	V
Over Temperature Protection	OTP		--	170	--	°C
Shut Down Voltage	V_{EN}		--	--	0.4	V
Enable Voltage	V_{EN}		1.5	--	--	V

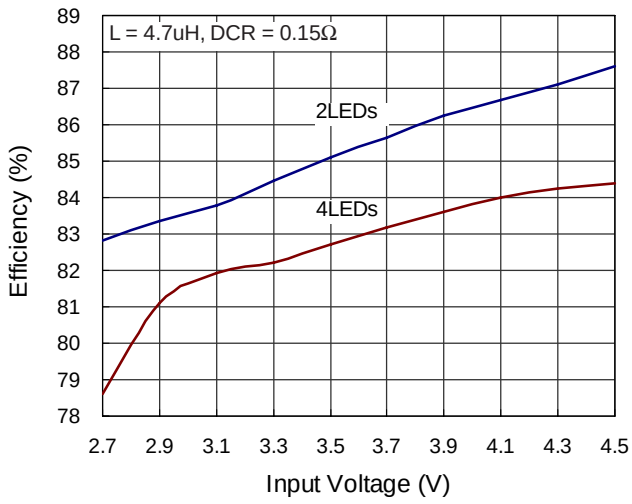
Note 1. Stresses listed as the above "Absolute Maximum Ratings" may cause permanent damage to the device. These are for stress ratings. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may remain possibility to affect device reliability.

Note 2. θ_{JA} is measured in the natural convection at T_A = 25°C on a low effective thermal conductivity test board of JEDEC 51-3 thermal measurement standard.

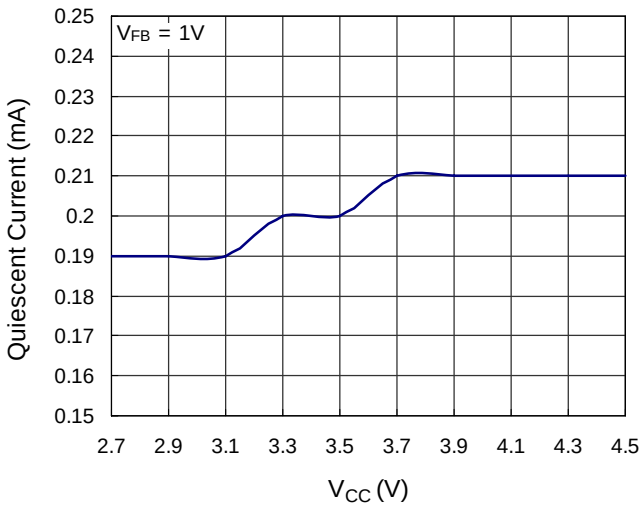
Note 3. The device is not guaranteed to function outside its operating conditions.

Typical Operating Characteristics

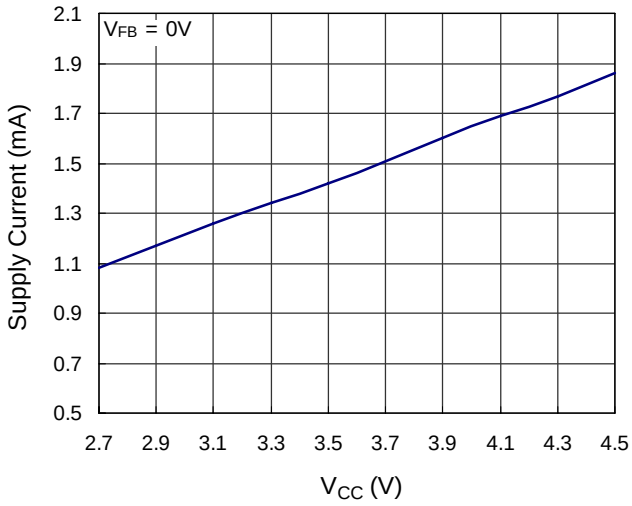
Efficiency vs. Input Voltage



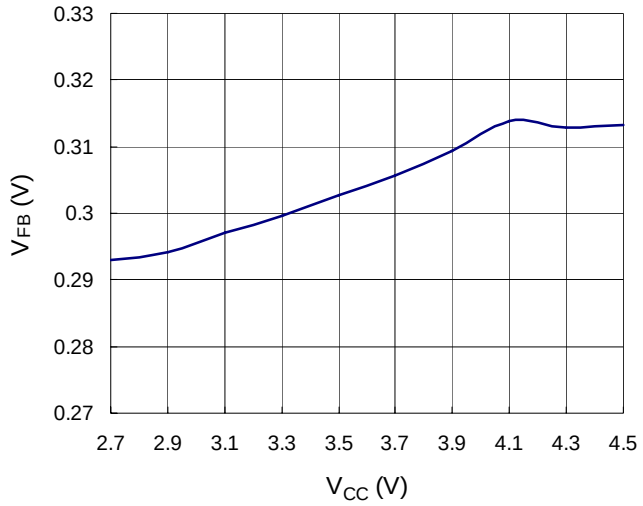
Quiescent Current vs. V_{CC}



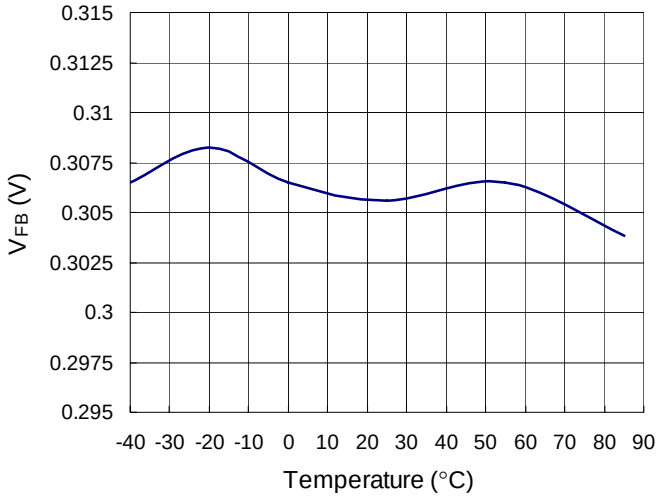
Supply Current vs. V_{CC}



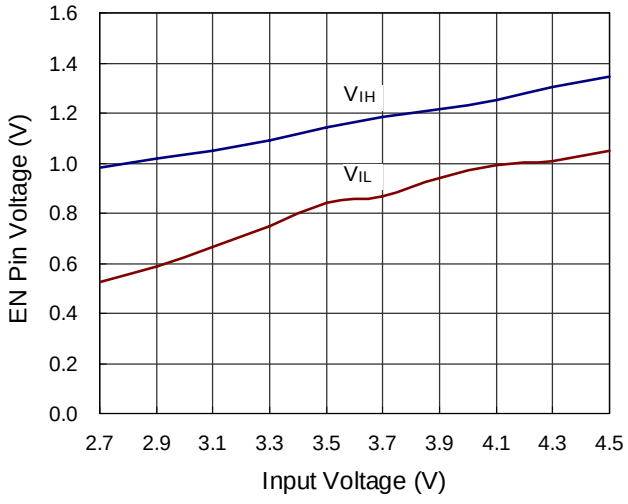
V_{FB} vs. V_{CC}



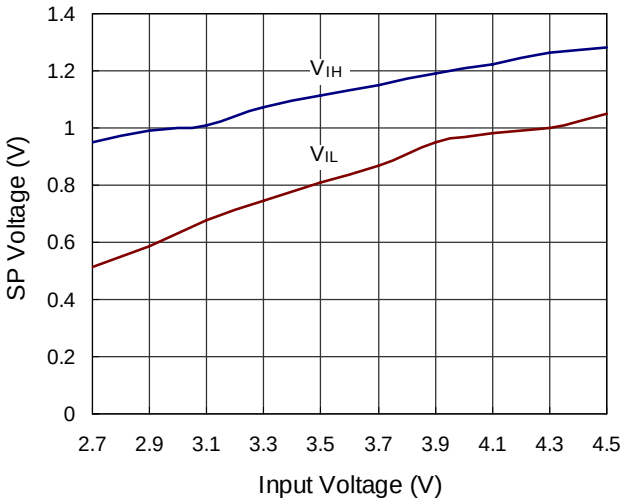
V_{FB} vs. Temperature



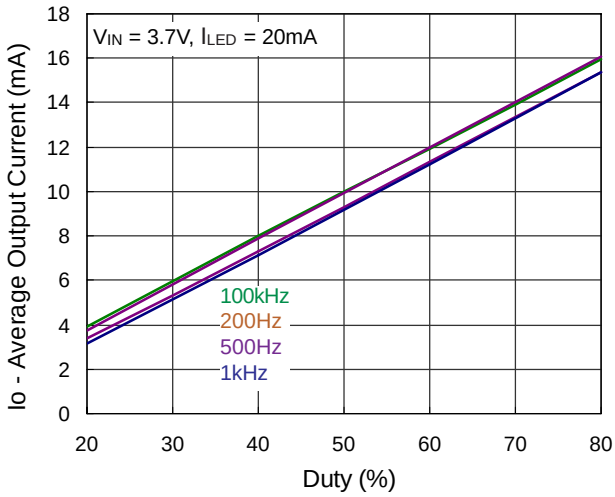
EN Pin Voltage vs. Input Voltage



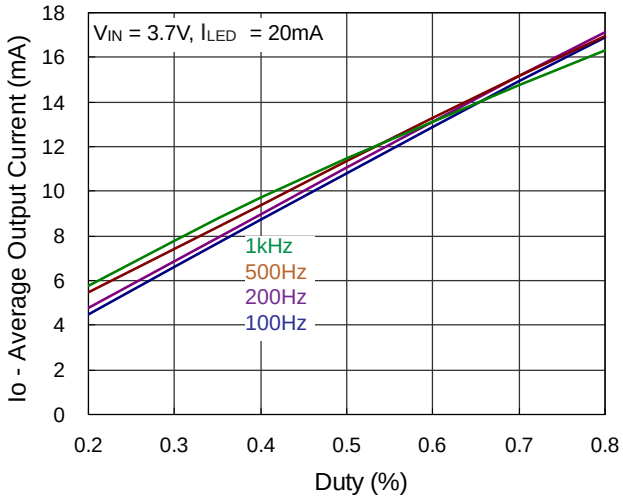
SP Voltage vs. Input Voltage



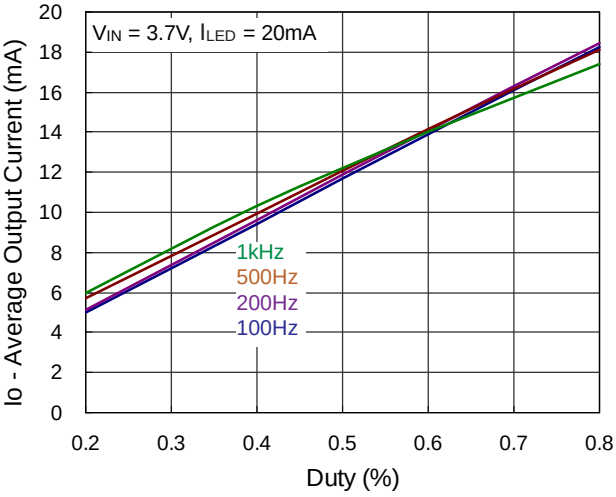
Dimming Control for 4LEDs



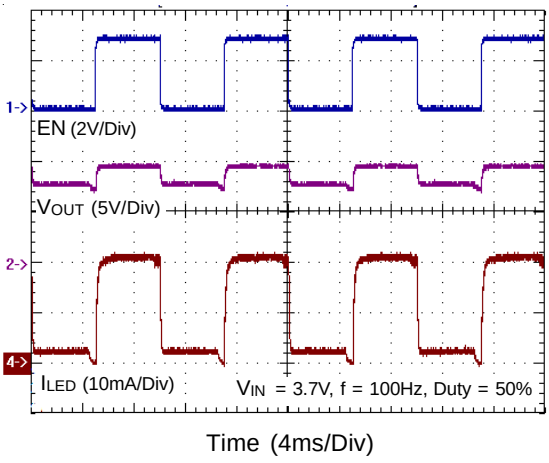
Dimming Control for 3LEDs



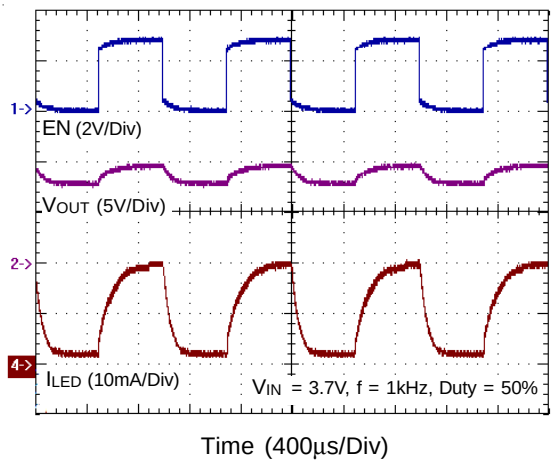
Dimming Control for 2LEDs



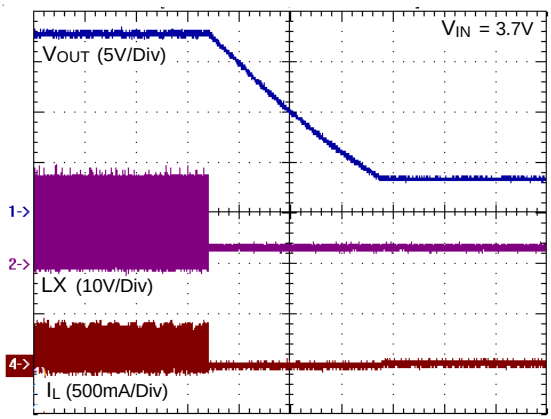
Dimming Operation for 3LEDs



Dimming Operation for 3LEDs



OVP



Application Information

Inductor Selection

The recommended value of inductor for RT9272 applications is 4.7µH. Small size and better efficiency are the major concerns for portable device, such as RT9272 used for dual panel mobile phone. The inductor should have low DCR for better efficency. To avoid inductor saturation, current rating should be at least 600mA for 3LEDs application in the input range 2.7V to 4.5V.

Capacitor Selection

2.2µF input and 1µF output ceramic capacitors are recommended for RT9272 applications. 2.2uF input capacitor can reduce input ripple. For better voltage stability, to increase the input capacitor value or using LC filter is feasible, especially in the Li-ion battery application. 1µF output capacitor is sufficient to reduce output voltage ripple. For better voltage filtering, ceramic capacitors with low ESR are recommended. X5R and X7R types are suitable because of their wider voltage and temperature ranges.

Diode Selection

Schottky diode is a good choice for RT9272 because of its lower forward voltage drop and faster reverse recovery. Using schottky diode can get better efficiency. The high-speed rectification is also a good characteristic of schottky diode for high switching frequency. Current rating of the diode must meet the root mean square of the peak current and output average current multiplication as following:

$$I_{Diode\ (RMS)} \cong (\sqrt{I_{OUT} \times I_{PEAK}})$$

The diode'sreverse breakdown voltage should be larger than the output voltage. SS0520 is recommended schottky diode for rectifier.

LED Current Control

Current control is to change different brightness of LEDs. To regulate the output resistor can get different currents of LEDs as following formula.

$$FB\_resister\ (\Omega) = \frac{0.3\ (V)}{I_{LED}\ (mA)}$$

Dimming Control

Dimming control is the current programming method when output resistor fixes the brightness of LEDs. Using a PWM signal on EN pin can achieve the dimming control. RT9272 is turned on or off by the PWM signal applied to EN pin. The brightness of LEDs for CH1 or CH2 is depended on PWM duty cycle. By selecting the different channel, it can achieve the dimming control function for main panel or sub panel. The average LED current increases proportionally as the duty cycle added. The operation frequency of PWM signal is 100Hz to 1kHz. The average LED current is linear in different duty cycle. It should be notice that the magnitude of PWM signal should be higher than the minimum EN voltage.

Channel Selection

There is one set of LC filter for RT9272 to share two channels power requirement. Each time turning on only one channel can save the power dissipation and easily extend the standby time. Selection pin is internal logic controller. SP pin is pulled low to turn on the internal channel 1 and pulling high to turn on channel 2. As the input signal change, internal MOSFET of LX pin will turn off 1ms to prevent the over voltage damage by the output voltage instant change.

Layout Guide

- A full GND plane without gap break.
- The input capacitor should be placed as close as possible to the input for good filtering.
- The switching path should be shorter to prevent EMI problems.
- The inductor and diode must be placed closely to the switch pin.
- The feedback path should be away from the inductor.
- The feedback resistor should be connected directly to the GND.

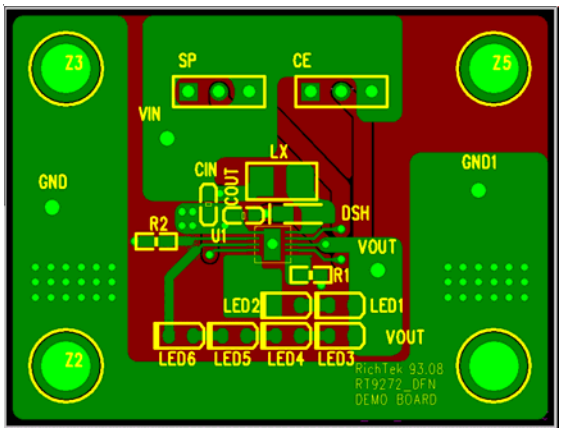


Figure 1. Top Layer

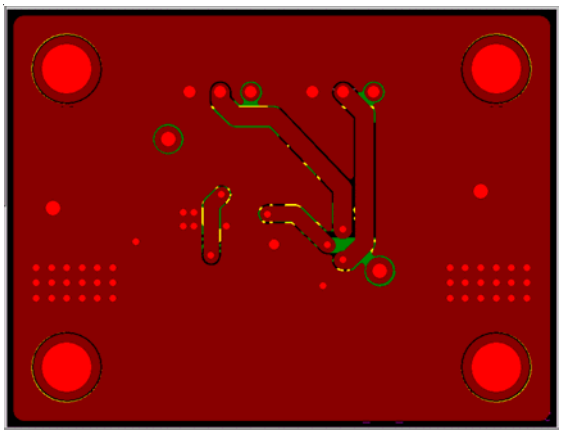
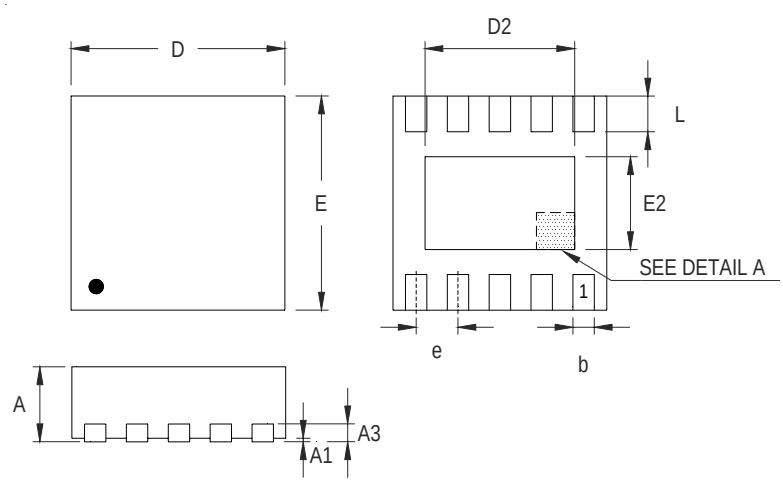
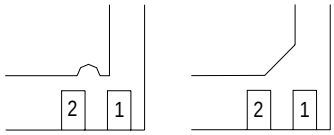


Figure 2. Bottom Layer

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	0.180	0.300	0.007	0.012
D	2.950	3.050	0.116	0.120
D2	2.300	2.650	0.091	0.104
E	2.950	3.050	0.116	0.120
E2	1.500	1.750	0.059	0.069
e	0.500		0.020	
L	0.350	0.450	0.014	0.018

V-Type 10L DFN 3x3 Package

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