Small Package, High Performance, Diode Embedded, Asynchronous Boost, 6 WLEDs Driver

General Description

The RT8565 is a high efficiency LED driver IC capable of driving 6 LEDs. The RT8565 integrates 26V/0.9A power switch with an internal Schottky diode.

The RT8565 is a current mode boost converter which is fixed at 600kHz operating frequency and has a wide input voltage range from 2.8V to 4.5V.

The LED current is set with an external resistor and the feedback voltage is regulated to 200mV. During operation, an internal 6-bit DAC is used for brightness control. Users can easily configure up to 64 steps of LED current via the EN pin.

During brightness dimming, the RT8565 does not burst the LED current. Therefore, no audible noises are generated on the output capacitor. The RT8565 also has internal over voltage protection setting to prevent the output from exceeding the absolute maximum ratings during open LED conditions.

The RT8565 is available in a small WQFN-8L 1.6x1.6 package.

Ordering Information

RT8565 □□

- Package Type
  QW : WQFN-8L 1.6x1.6 (COL) (W-Type)
- Lead Plating System
  G : Green (Halogen Free and Pb Free)

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.

Features

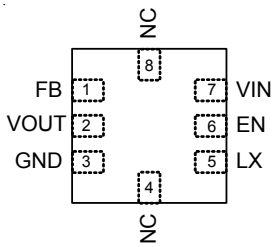
- **Internal Schottky Diode**
- **Internal Soft-Start and Compensation**
- **200mV Reference Voltage**
- **64-Step Pulse Dimming**
- **Open LED Protection**
- **Internally Set Over Voltage Protection**
- **Over Temperature Protedtion**
- **Current Limit Protection**
- **RoHS Compliant and Halogen Free**

Applications

- GPS, Portable DVD Backlight
- Mobile Phone, Smart Phone

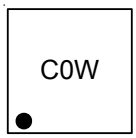
Pin Configurations

(TOP VIEW)



WQFN-8L 1.6x1.6 (COL)

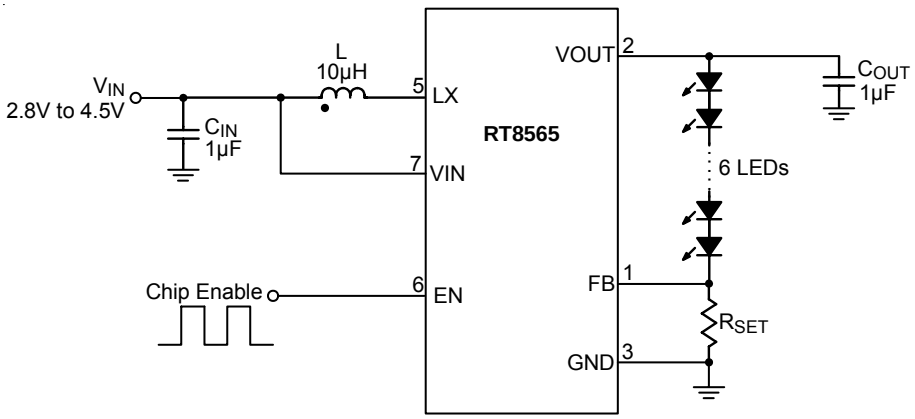
Marking Information



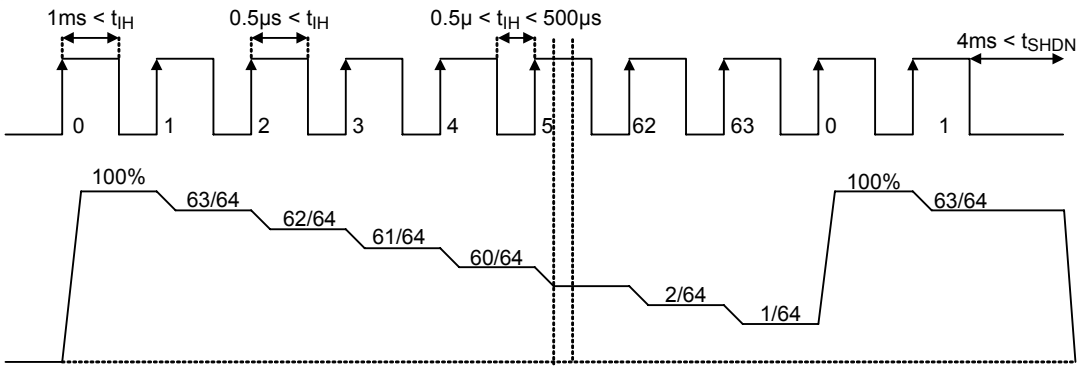
C0 : Product Code

W : Date Code

Typical Application Circuit



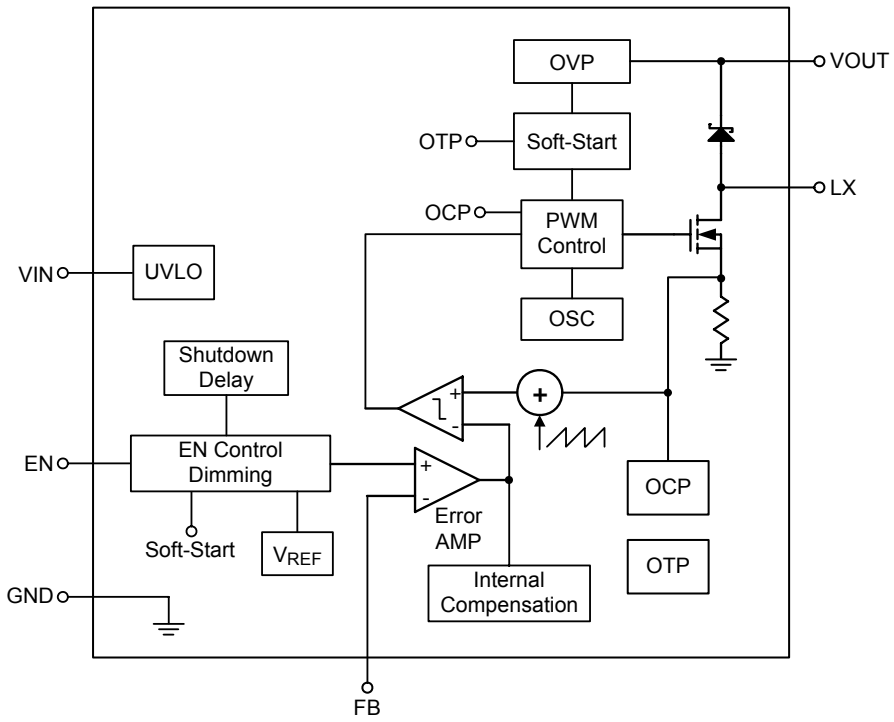
Timing Diagram



Functional Pin Description

Pin No.	Pin Name	Pin Function
1	FB	Feedback Voltage Input. Connect a resistor from this pin to GND to set the LED current.
2	VOUT	Boost Converter Output.
3	GND	Ground.
4, 8	NC	No Internal Connection.
5	LX	Switch Node of Boost Converter.
6	EN	Chip Enable (Active High).
7	VIN	Power Supply Input.

Function Block Diagram



Absolute Maximum Ratings (Note 1)

- Supply Input Voltage, V_{IN} to GND ---------- –0.3V to 5.4V
- EN, FB to GND ---------- –0.3V to 5.4V
- LX, VOUT to GND ---------- –0.3V to 40V
- Power Dissipation, P_D @ T_A = 25°C
  WQFN–8L 1.6x1.6 (COL) ---------- 0.833W
- Package Thermal Resistance (Note 2)
  WQFN–8L 1.6x1.6 (COL), θ_{JA} ---------- 120°C/W
- Lead Temperature (Soldering, 10 sec.) ---------- 260°C
- Junction Temperature ---------- 150°C
- Storage Temperature Range ---------- –65°C to 150°C

Recommended Operating Conditions (Note 3)

- Supply Input Voltage ---------- 2.8V to 4.5V
- Junction Temperature Range ---------- –40°C to 125°C
- Ambient Temperature Range ---------- –40°C to 85°C

Electrical Characteristics

(V_{IN} = 3.6V, T_A = 25°C, unless otherwise specified)

Parameter		Symbol	Test Conditions	Min	Typ	Max	Unit
Under Voltage Lockout Threshold		V_{UVLO}	V_{IN} Rising	2	2.2	2.45	V
Under Voltage Lockout Hysteresis		ΔV_{UVLO}		--	0.1	--	V
VIN Quiescent Current		I_{VCC}	FB = 1.5V, Not Switching	--	850	--	μA
		I_{VCC_SW}	FB = 0V, Switching	--	--	3	mA
VIN Shutdown Current		I_{SHDN}	V_{IN} = 4V, $V_{EN} \leq$ 0.8V	--	1	4	μA
Control Input							
EN Threshold Voltage	Logic-High	V_{IH}		1.5	--	--	V
	Logic-Low	V_{IL}		--	--	0.4	
EN Sink Current		I_{IH}		1	--	10	μA
EN Dimming Time	Logic-Low	t_{IL}		0.5	--	500	μs
	Logic-High	t_{IH}		0.5	--	--	
Shutdown Delay Time		t_{SHDN}		4	--	--	ms
Boost Converter							
Switching Frequency		f_{OSC}		–20%	0.6	20%	MHz
LX On-Resistance (N-MOSFET)		$R_{DS(ON)}$		--	0.5	0.7	Ω
Minimum ON Time		t_{ON}		--	100	--	ns
Maximum Duty		D_{MAX}		--	92	--	%
Feedback Reference Voltage		V_{REF}		–5%	200	5%	mV
Fault Protection							
LX Current Limit		I_{LIM}		--	0.9	--	A
Over Voltage Protection		V_{OVP}		--	26	--	V
Thermal Shutdown Temperature		T_{SD}		--	160	--	°C
Thermal Shutdown Hysteresis		ΔT_{SD}		--	30	--	°C

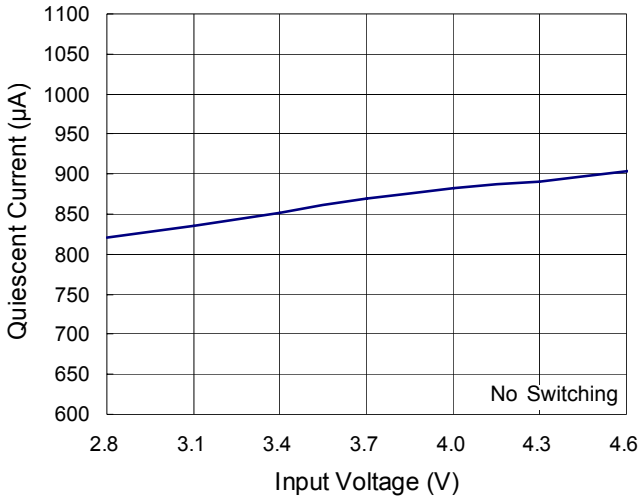
Note 1. Stresses listed as the above "Absolute Maximum Ratings" may cause permanent damage to the device. These are for stress ratings. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure 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 high effective thermal conductivity four-layer test board of JEDEC 51-7 thermal measurement standard.

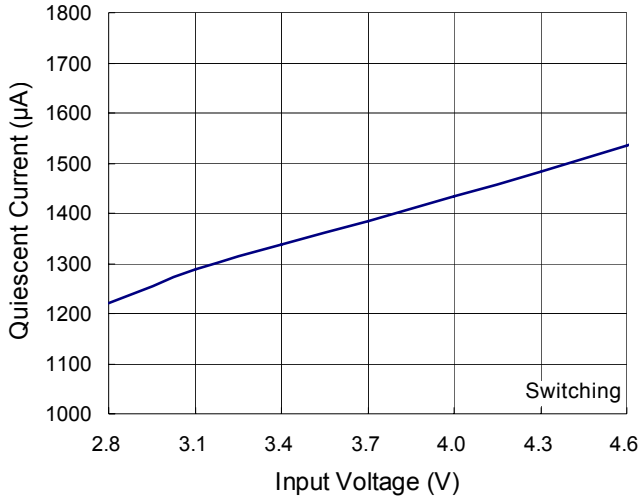
Note 3. The device is not guaranteed to function outside its operating conditions.

Typical Operating Characteristics

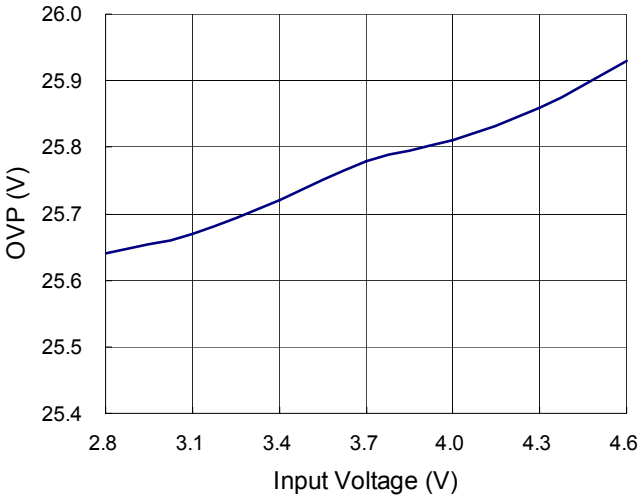
Quiescent Current vs. Input Voltage



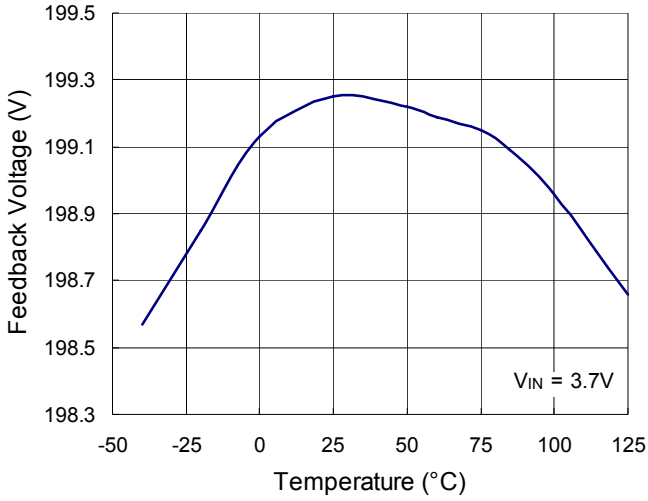
Quiescent Current vs. Input Voltage



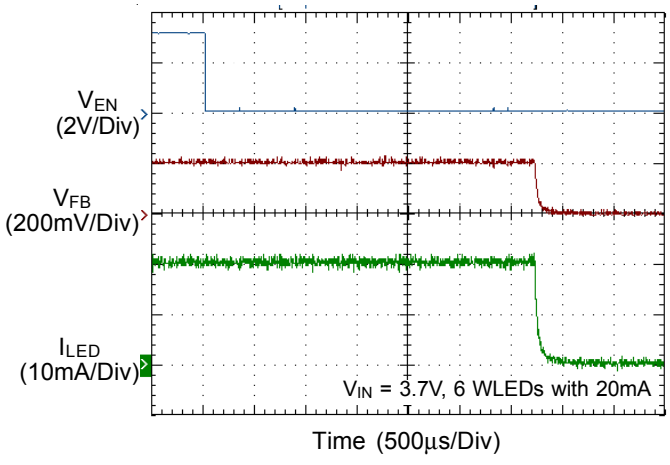
OVP vs. Input Voltage



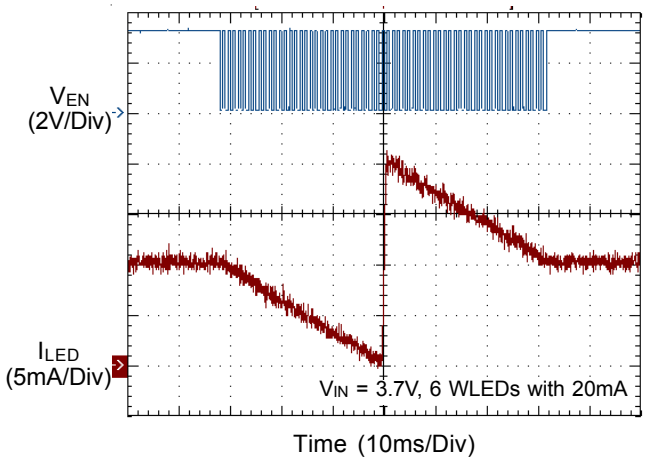
Feedback Voltage vs. Temperature



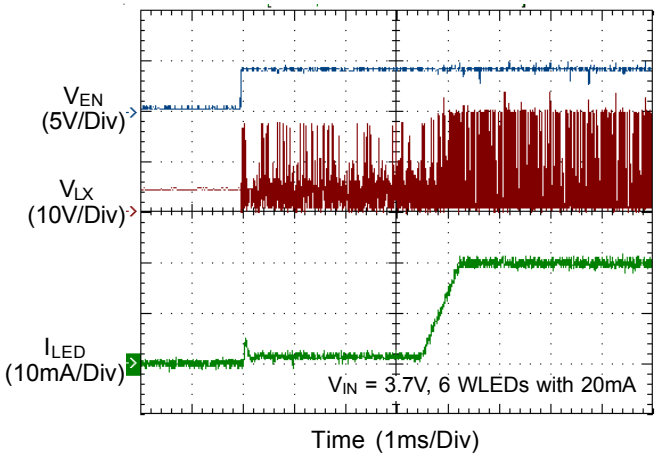
Power Off



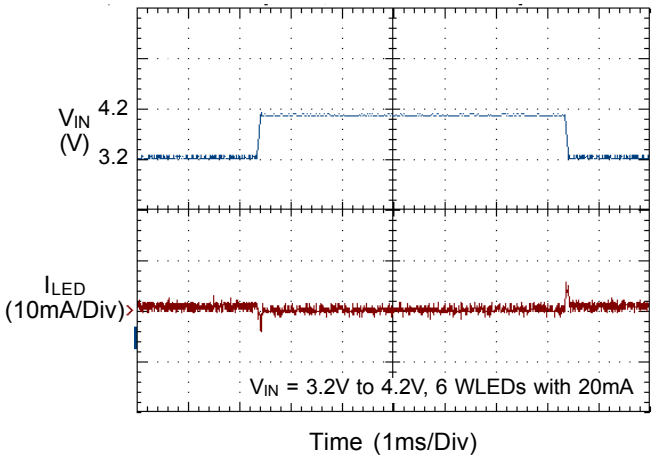
Pulse Dimming for LED Current



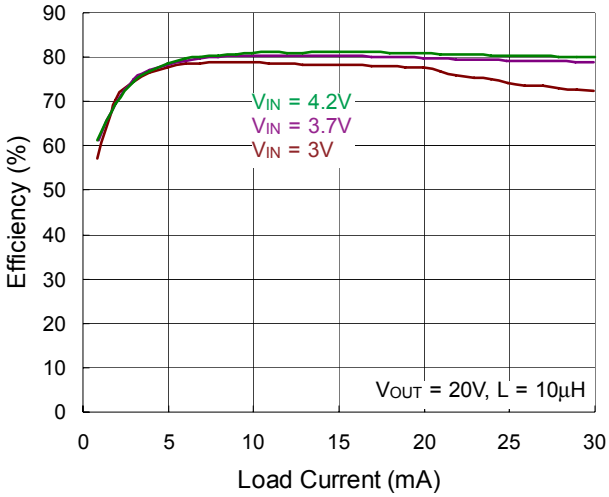
Soft-Start



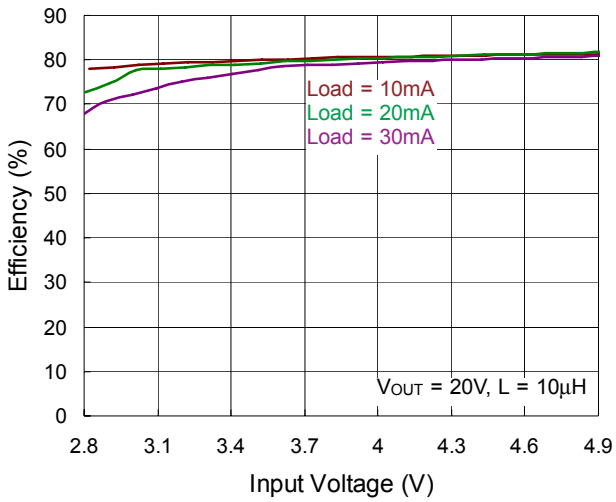
Line Transient Response



Efficiency vs. Load Current



Efficiency vs. Input Voltage



Application Information

Soft-Start

The function of Soft-Start is to avoid high inrush current during start-up

LED Current

The loop control of the boost converter keeps V_{FB} equal to a reference voltage V_{REF}. Therefore, when R_{SET} is connected between the FB pin and GND, the LED current will be determined by the current through R_{SET}, which is equal to V_{FB} / R_{SET}.

Brightness Dimming

The RT8565 implements a pulse dimming method to control the brightness of the white LEDs. Users can easily configure the LED current with a serial pulse. The dimming of white LED current can be achieved by applying a pulse signal to the EN pin. There are a total of 64 steps of current levels that can be set by users. The detail operation of the brightness dimming is shown in Timing Diagram.

Current Limiting

The current flowing through the inductor during the charging period is detected by a current sensing circuit. If the value over the current limit, the N-MOSFET will be turned off. The inductor will then be forced to leave charging stage and enter discharging stage. Therefore, the inductor current will not increase over the current limit.

Shutdown Delay

When the EN voltage is in logic-low for 4ms typical during for pulse dimming, the system will enter shutdown.

OVP/UVLO/OTP

When the output voltage is higher than a specified value or input voltage is lower than a specified value, the IC will enter protection mode to prevent abnormal operation. If the die temperature > 160°C, the IC will also enter protection mode. The power MOSFET will be turned off during protection mode to prevent abnormal operation.

Inductor Selection

The recommended Inductor value for 6-WLED applications is from 10μH to 22μH. Small size and better efficiency are the major concerns for portable devices, such as for mobile phone. The inductor should have low core loss at 600kHz and low DCR for better efficiency. The inductor saturation current rating should be able to cover the inductor peak current.

Capacitor Selection

Input ceramic capacitor of 1μF and output ceramic capacitor of 1μF are recommended for driving 6-WLED applications. For better voltage filtering, ceramic capacitors with low ESR are recommended. X5R and X7R types are suitable because of their wide voltage and temperature ranges.

Thermal Considerations

For continuous operation, do not exceed absolute maximum junction temperature. The maximum power dissipation depends on the thermal resistance of the IC package, PCB layout, rate of surrounding airflow, and difference between junction and ambient temperature. The maximum power dissipation can be calculated by 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 recommended operating condition specifications of the RT8565, the maximum junction temperature is 125°C and T_A is the ambient temperature. The junction to ambient thermal resistance, θ_{JA}, is layout dependent. For WQFN-8L 1.6x1.6 packages, the thermal resistance, θ_{JA}, is 120°C/W on a standard JEDEC 51-7 four-layer thermal test board. The maximum power dissipation at T_A = 25°C can be calculated by the following formula :

$P_{D(MAX)}$ = (125°C – 25°C) / (120°C/W) = 0.833W for WQFN-8L 1.6x1.6 package

The maximum power dissipation depends on operating ambient temperature for fixed $T_{J(MAX)}$ and thermal resistance. For the RT8565 package, the derating curve in Figure 1 allows the designer to see the effect of rising ambient temperature on the maximum power dissipation.

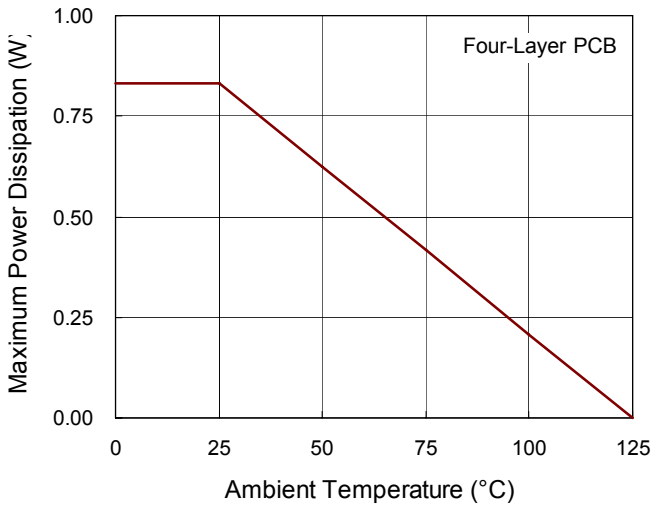


Figure 1. Derating Curve for the RT8565 Package

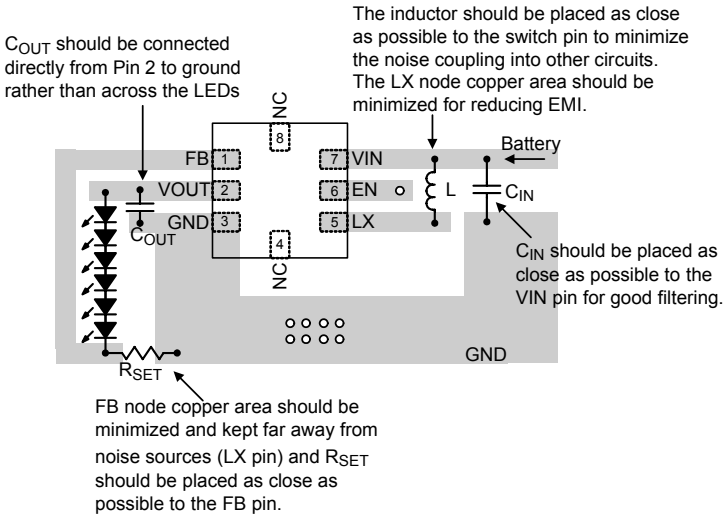


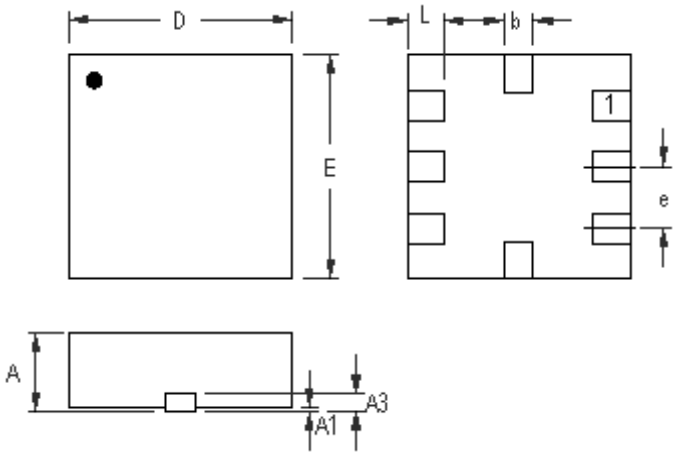
Figure 2. PCB Layout Guide

Layout Consideration

For best performance of the RT8565, the following guidelines must be strictly followed :

- Input and output capacitors should be placed close to the IC and connected to the ground plane to reduce noise coupling.
- GND and Exposed Pad should be connected to a strong ground plane for heat sinking and noise protection.
- Keep the main current traces as short and wide as possible.
- LX node of DC/DC converter experiences high frequency voltage swings. It should be kept in a small area.
- Place the feedback components as close as possible to the IC and away from the noisy devices.

Outline Dimension



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.700	0.800	0.028	0.031
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	1.550	1.650	0.061	0.065
E	1.550	1.650	0.061	0.065
e	0.400		0.016	
L	0.350	0.450	0.014	0.018

W-Type 8L QFN 1.6x1.6 (COL) Package

Richtek Technology Corporation
Headquarter
5F, No. 20, Taiyuen Street, Chupei City
Hsinchu, Taiwan, R.O.C.
Tel: (8863)5526789 Fax: (8863)5526611

Richtek Technology Corporation
Taipei Office (Marketing)
5F, No. 95, Minchiuan Road, Hsintien City
Taipei County, Taiwan, R.O.C.
Tel: (8862)86672399 Fax: (8862)86672377
Email: marketing@richtek.com