Tiny Package, High Performance, Regulated Charge Pump

General Description

The RT9361A/B is a high performance charge pump DC/DC converter that produces a regulated 4.5V and 5V output. No external inductor is required for operation. The operating voltage range is 2.8V to Vout. Internal soft-start circuitry effectively reduces the in-rush current both while start-up and mode change.

The RT9361A/B features very low quiescent current, over current protection and short circuit protection.

The RT9361A/B is available in SOT-23-6 package.

Ordering Information

RT9361A/B □ □

- Package Type
  E : SOT-23-6
- Operating Temperature Range
  C : Commercial Standard
  P : Pb Free with Commercial Standard
- Output Voltage
  A : 5V
  B : 4.5V

Note :

RichTek Pb-free 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

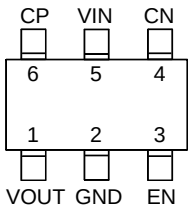
- **Input Voltage Range : 2.8V to V_{OUT}**
- **Internal Soft Start Function**
- **5V/4.5V Fixed Output Voltage**
- **Over Current Protection Function**
- **Short Circuit Protection Function**
- **RoHS Compliant and 100% Lead (Pb)-Free**

Applications

- Mobile phone, Smart Phone LED Backlight
- Camera Flash White LED
- LCD Display Supply

Pin Configurations

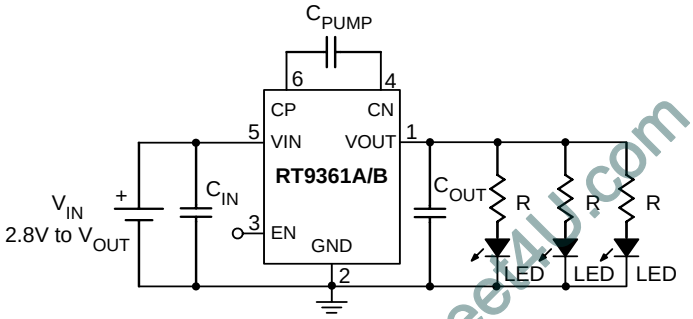
(TOP VIEW)



SOT-23-6

Note : There is no pin1 indicator on top mark for SOT-23-6 type, and pin1 will be lower left pin when reading top mark from left to right.

Typical Application Circuit



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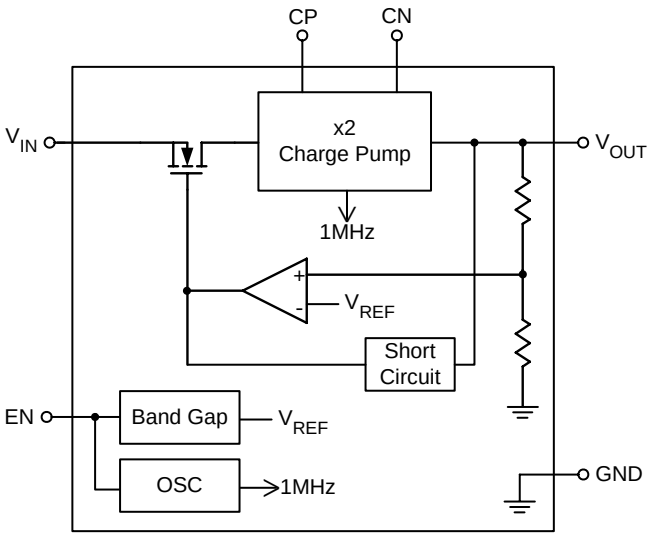
Part No.	Application Configuration	C_{IN} (uF)	C_{PUMP} (uF)	C_{OUT} (uF)
RT9361A	I_{OUT}<60mA@ V_{IN}>3.2V,	1 or 2.2	0.22	1 or 2.2
	I_{OUT}<110mA@ V_{IN}>3.2V,	10	1	10
RT9361B	I_{OUT}<80mA@ V_{IN}>3.2V,	1 or 2.2	0.22	1 or 2.2
	I_{OUT}<150mA@ V_{IN}>3.2V,	10	1	10

Functional Pin Description

Pin Number	Pin Name	Pin Function
1	VOUT	Output Voltage
2	GND	Ground
3	EN	Chip Enable (Active High)
4	CN	Flying Capacitor Negative Terminal
5	VIN	Power Input Voltage
6	CP	Flying Capacitor Positive Terminal

Function Block Diagram



Absolute Maximum Ratings (Note 1)

- Supply Input Voltage ---------- –0.3V to 6V
- Other I/O Pin Voltages ---------- –0.3V to 6V
- Power Dissipation, P_D @ T_A = 25°C
  SOT-23-6 ---------- 0.4W
- Package Thermal Resistance (Note 4)
  SOT-23-6, θ_{JA} ---------- 250°C/W
- Lead Temperature (Soldering, 10 sec.) ---------- 260°C
- Junction Temperature Range ---------- –40°C to 125°C
- Storage Temperature Range ---------- –65°C to 150°C
- ESD Susceptibility (Note 2)
  HBM (Human Body Mode) ---------- 2kV
  MM (Machine Mode) ---------- 200V

Recommended Operating Conditions (Note 3)

- Operation Temperature Range ---------- –40°C to 85°C

Electrical Characteristics

(V_{IN} = 3.7V, T_A = 25°C, unless otherwise specified)

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
Operation Voltage Range	V_{IN}	V_{OUT} = 5V	2.8	--	V_{OUT}	V
Output Voltage	V_{OUT}	RT9361A , V_{IN}>3.2V, I_{OUT}<110mA	4.8	5	5.2	V
	V_{OUT}	RT9361B , V_{IN}>3.2V ,I_{OUT}<150mA	4.32	4.5	4.68	V
Quiescent Current	I_Q	I_{OUT} = 0,	--	2	4	mA
Maximum Output Current	I_{OUT}	RT9361A , V_{IN}>3.2V, C_{PUMP} = 1uF	110	--	--	mA
	I_{OUT}	RT9361B , V_{IN}>3.2V, C_{PUMP} = 1uF	150	--	--	mA
OCP		RT9361A	250	350	500	mA
		RT9361B	300	350	500	mA
Short Circuit Current			--	60	90	mA
Output Ripple		I_{OUT} = 60mA, C_{OUT} = 2.2uF	--	30	--	mV
Shut Down Current	I_{SHDN}	V_{IN} = 4.5V, V_{EN}<0.4V	--	0.1	1	uA
Operation Frequency	F_{OSC}		0.8	1	1.3	MHz
Digital Input High Level	V_{IH}		1.5	--	--	V
Digital Input Low Level	V_{IL}		--	--	0.4	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. Devices are ESD sensitive. Handling precaution recommended.

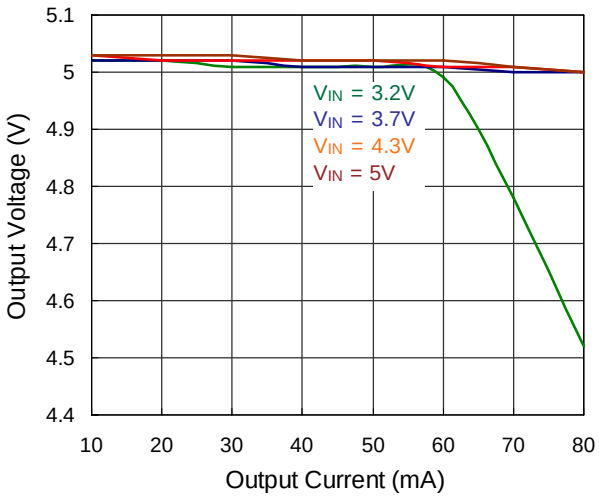
Note 3. The device is not guaranteed to function outside its operating conditions.

Note 4. 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.

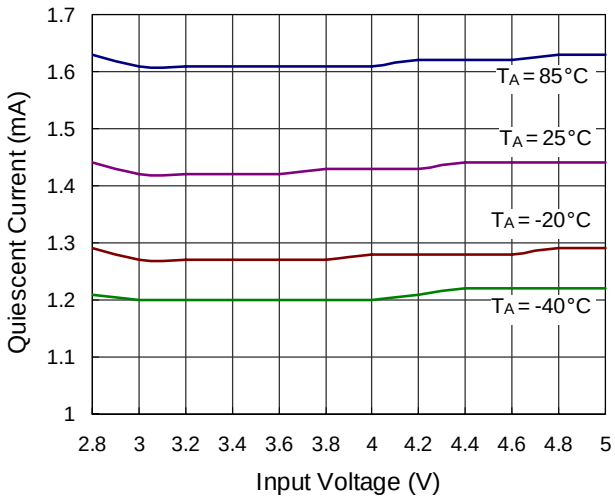
Typical Operating Characteristics

(For RT9361A, C_{IN} = C_{OUT} = 2.2µF, C_{PUMP} = 0.22µF, T_A = 25°C, unless otherwise specified)

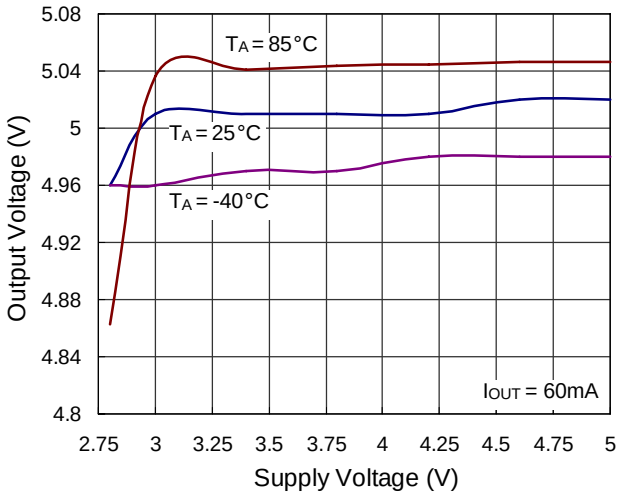
Output Voltage vs. Output Current



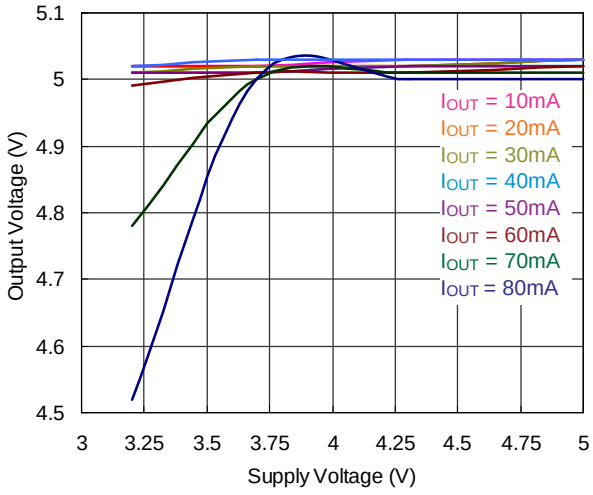
Quiescent Current vs. Input Voltage



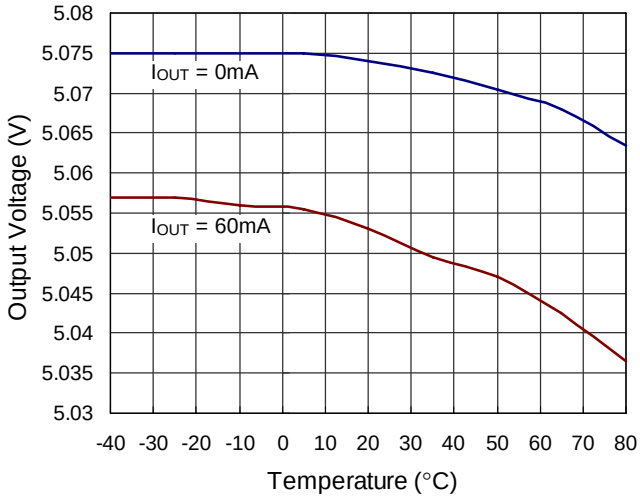
Output Voltage vs. Supply Voltage



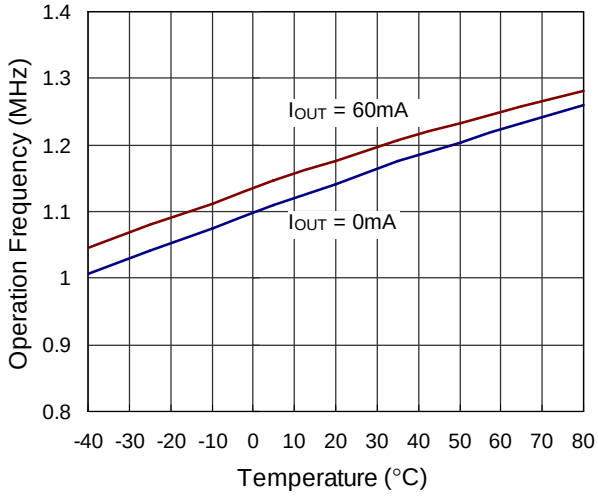
Output Voltage vs. Supply Voltage



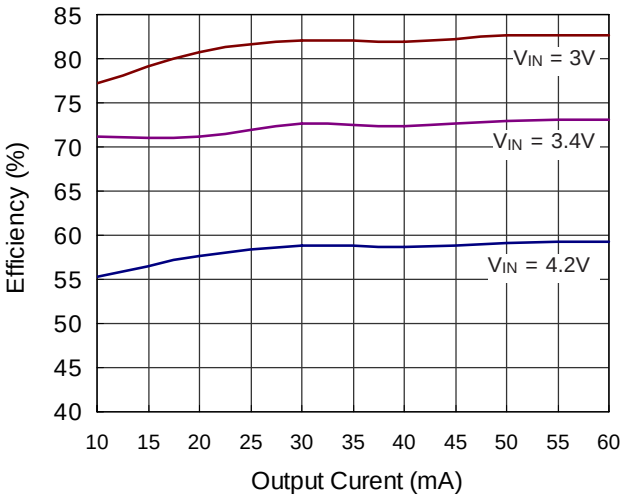
Output Voltage vs. Temperature



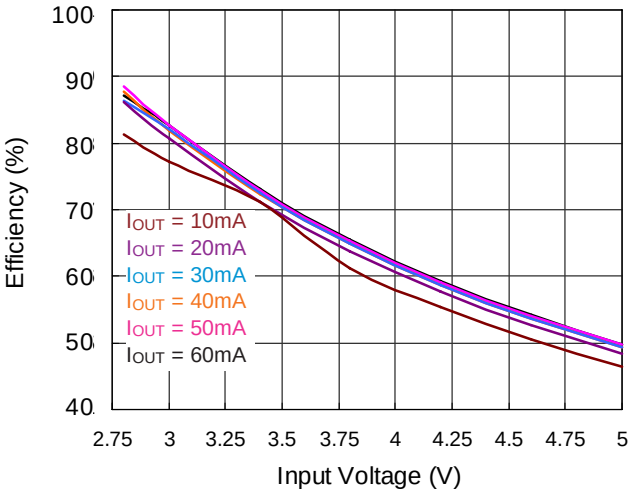
Operation Frequency vs. Temperature



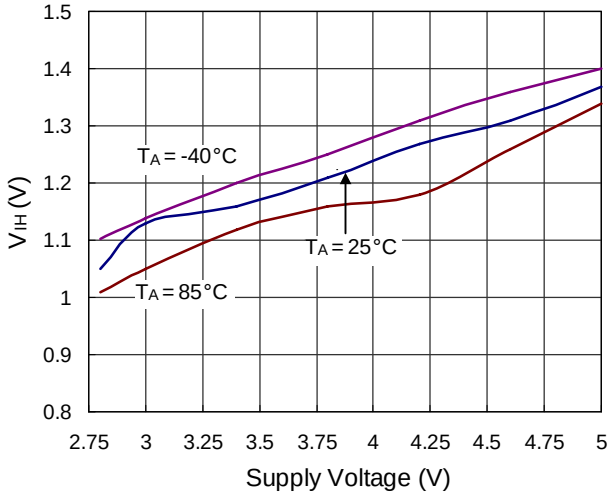
Efficiency vs. Output Curent



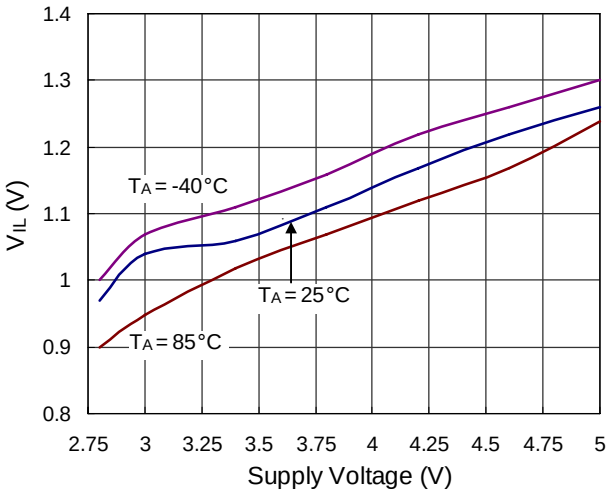
Efficiency vs. Input Voltage



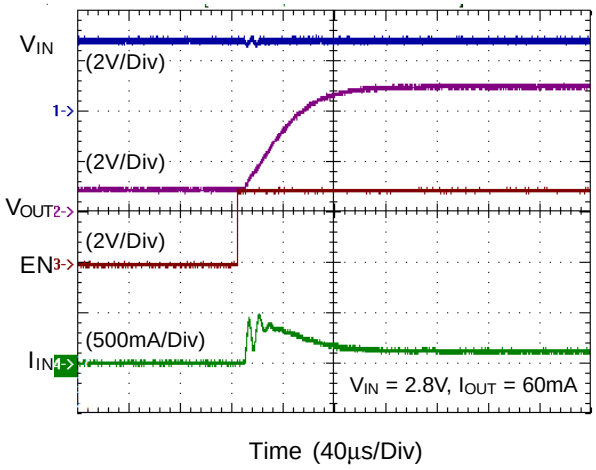
V_{IH} vs. Supply Voltage



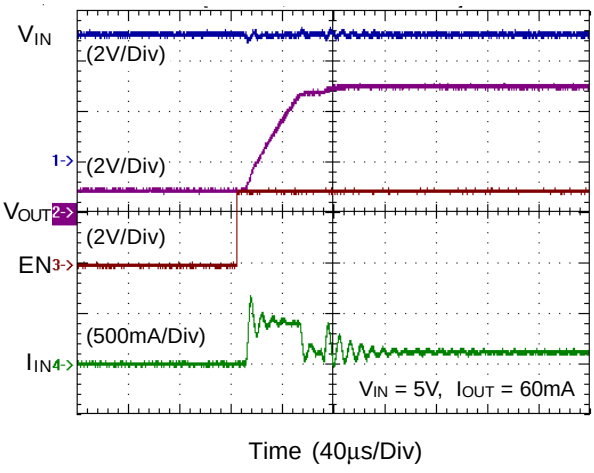
V_{IL} vs. Supply Voltage



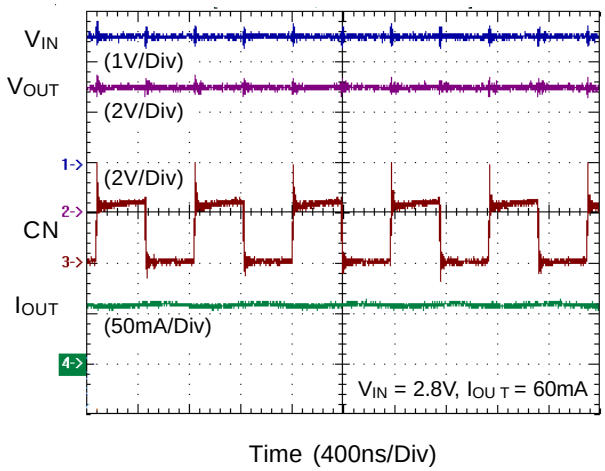
Inrush Current



Inrush Current

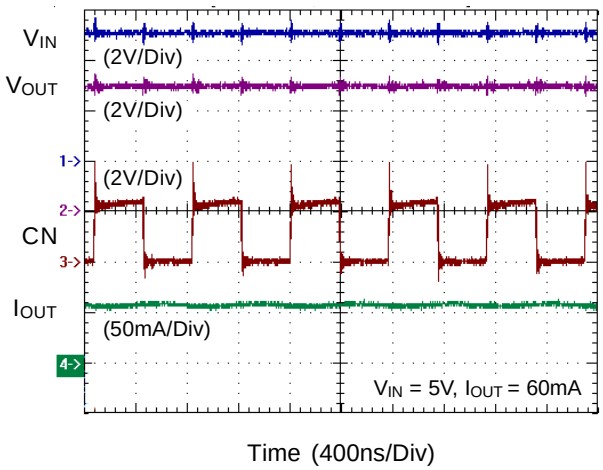


Normal Operation



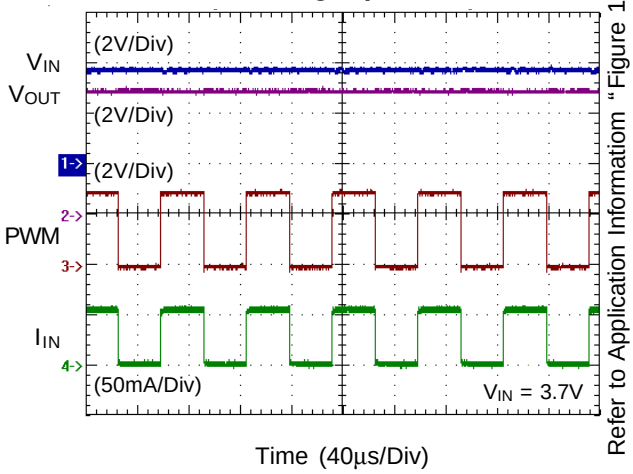
Time (400ns/Div)

Normal Operation



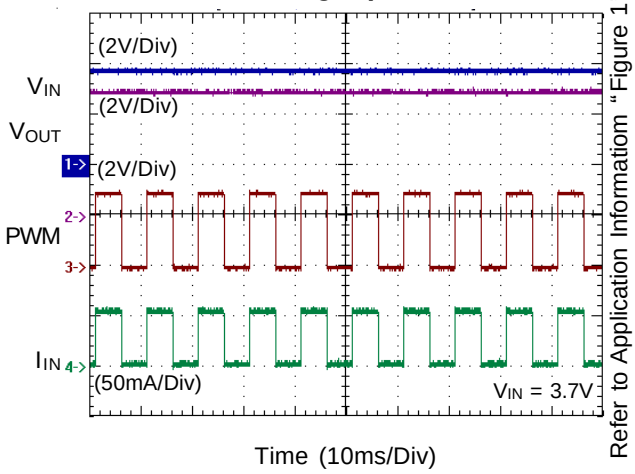
Time (400ns/Div)

Dimming Operation



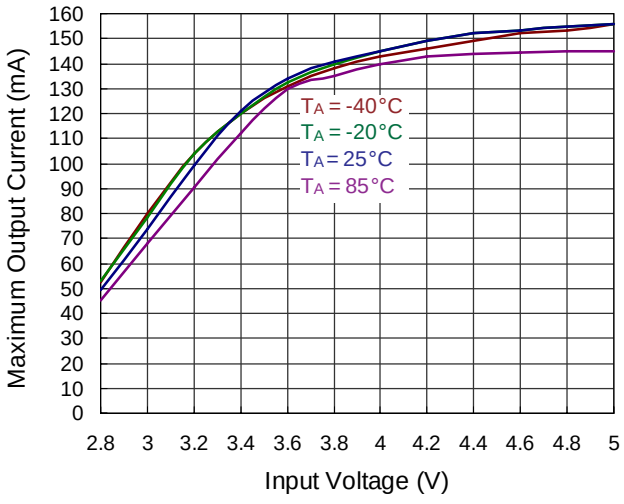
Time (40μs/Div)

Dimming Operation



Time (10ms/Div)

Maximum Output Current vs. Input Voltage



Application Information

Capacitor Selection

Careful selection of the three external capacitors C_{IN}, C_{OUT} and C_{PUMP} is very important because they will affect ramp-up time, output ripple and transient performance. Optimum performance will be obtained when low ESR (<100mΩ) ceramic capacitors are used for C_{IN} and C_{OUT} and C_{PUMP}. In general, low ESR may be defined as less than 100mΩ. In all cases, X7R or X5R dielectric are recommended. For particular application, low ESR Tantalum capacitors may be substituted; however optimum output ripple performance may not be realized. Aluminum electrolytic capacitors are not recommended for using with the RT9361A/B due the their inherent high ESR characteristic.

In general, lower values for C_{IN}, C_{OUT} and C_{PUMP} may be utilized for light load current applications (<60mA). Drawing a load current of 60mA or less may use a C_{IN} and C_{OUT} capacitor value as low as 2.2μF and a C_{PUMP} value of 0.22μF. C_{IN} and C_{OUT} may range from 1μF for light loads to 10μF for heavy output load conditions (<110mA). C_{PUMP} may range from 0.22μF for light loads to 1μF for heavy output load conditions. If C_{PUMP} is increased, C_{OUT} should also be increased by the same ratio to minimize output ripple. As a basic rule, the ratio between C_{IN}, C_{OUT} and C_{PUMP} should be approximately 10 to 1. Lowering the C_{IN}, C_{OUT} and C_{PUMP} value can decrease the ramp-up time of V_{OUT}, but it will increase the output ripple oppositely.

Efficiency

The efficiency of the charge pump regulator varies with the output voltage version, the applied input voltage, the load current, and the internal operation mode of the device.

The approximate efficiency is given by:

$$\text{Efficiency (\%)} = \frac{P_{OUT}}{P_{IN}} \times 100 = \frac{V_{OUT} \times I_{OUT}}{V_{IN} \times 2I_{OUT}} \times 100$$

$$= \frac{V_{OUT}}{2V_{IN}} \times 100 \text{---(} \times 2 \text{ Charge Pump Operating Mode)}$$

For a charge pump with an output of 5 volts and a nominal input of 3 volts, the theoretical efficiency is 83.33%. Due to internal switching losses and IC quiescent current consumption, the actual efficiency can be measured as 82.72%.

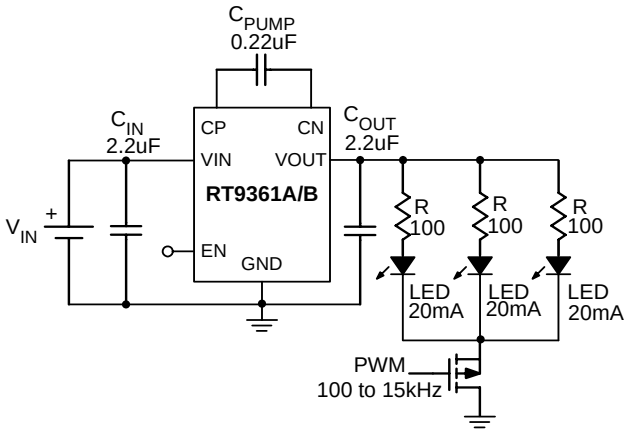


Figure 1. Application circuits for backlight dimming

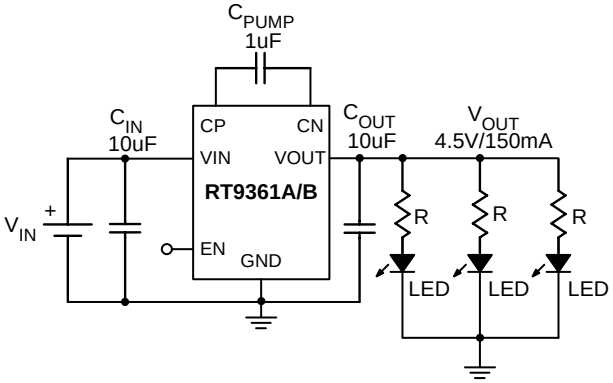


Figure 2. Application circuits for flash LEDs

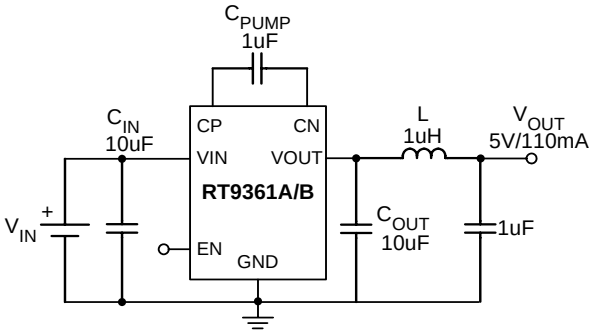


Figure 3. Application circuits for constant load

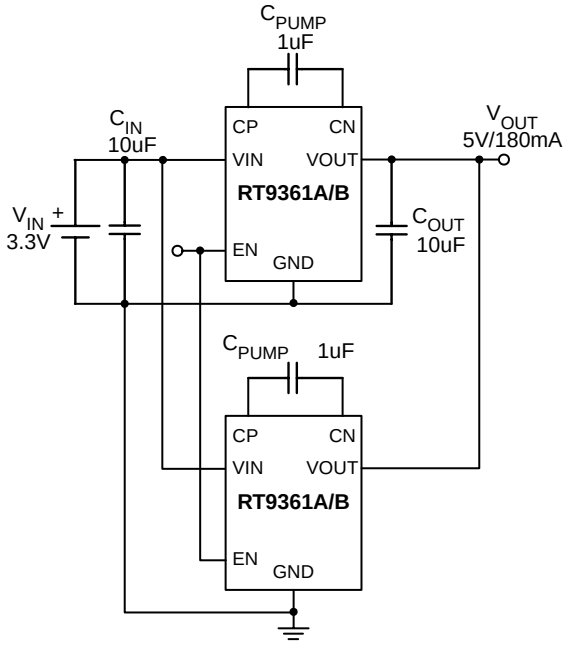


Figure 4. Application circuits for doubling the output current

PCB Board Layout

The RT9361A/B is a high-frequency switched-capacitor converter, and therefore large transient currents will flow in V_{IN} and V_{OUT}. For best performance and to minimize ripple, place all of the components as close to IC as possible. Besides a solid ground plane is recommended on the bottom layer of the PCB. The ground of C_{IN} and C_{OUT} should be connected together and as close to the IC as possible. Figure 5 and Figure 6 shows the typical PCB layout of RT9361A/B EVB board.

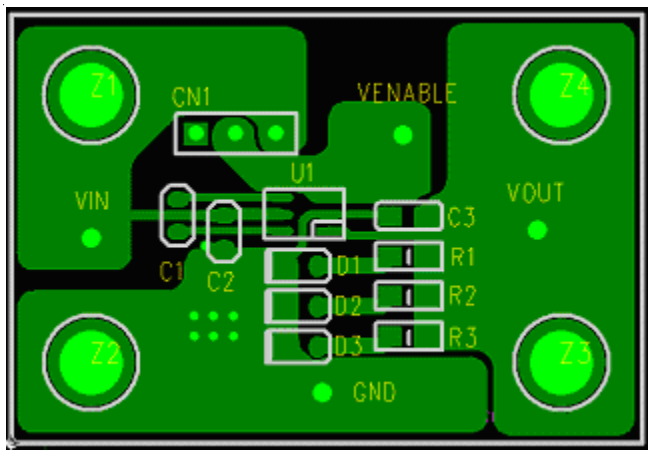


Figure 5

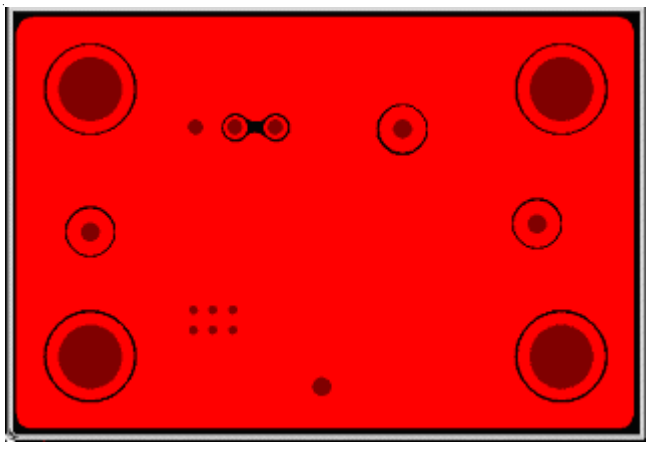
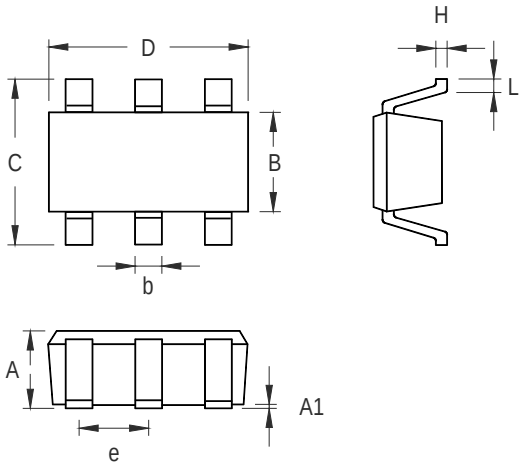


Figure 6

Outline Dimension



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.889	1.295	0.031	0.051
A1	0.000	0.152	0.000	0.006
B	1.397	1.803	0.055	0.071
b	0.250	0.560	0.010	0.022
C	2.591	2.997	0.102	0.118
D	2.692	3.099	0.106	0.122
e	0.838	1.041	0.033	0.041
H	0.080	0.254	0.003	0.010
L	0.300	0.610	0.012	0.024

SOT-23-6 Surface Mount Package

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