RS9360A/B

Charge-Pump White LED Driver

Description

The RS9360 is a compact, high efficient and high integration charge pump with current matched white LED driver. It can support 1 to 4 White LED's and optimized for Li-Ion battery applications. The four WLEDs current are matched for consistent brightness. User can control WLED on/off via three programming bits. The every WLED channel can support up to 30mA current.

Features

- With Current Source
- Drives Up to Four LEDs
- Soft Start Function & Short Circuit Protection
- High Efficiency: Over 90%
- 250KHz/1MHz Fixed Frequecny CSC.
- Three Charge-pump Mode: X1,X1.5,X2
- QFN-16L4X4 Pb-Free Packaging
- Compatible RT9360& SC604 & MPS1519 & AAT3140 & MAX1910 & FAN5607 & LM2794 & CAT3604

Applications

- Cellular Phones & White Photo Flash for DSC
- Color (RGB) Lightng
- PDAs, Hand-held Computers GPS Receivers
- White LED Backlighting

Pin Connections

QFN-16L 4x4
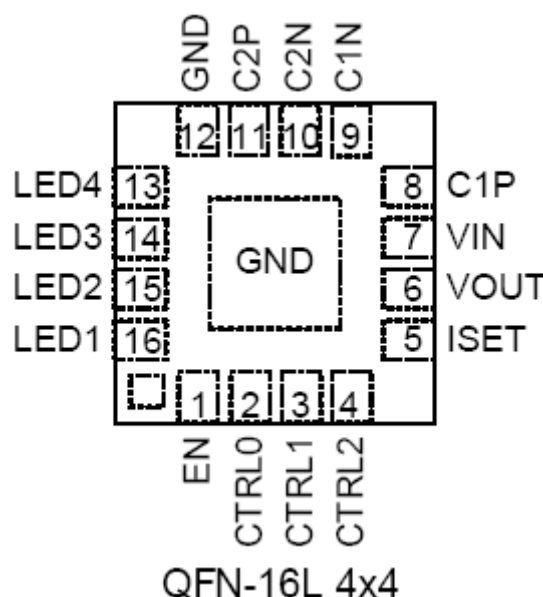
Pin Descriptions

Pin Number	Pin Name	Pin Function
1	EN	Chip Enable (Active High). Note that this pin is high impedance. There should be a pull low 100kΩ resistor connected to GND when the control signal is floating.
2	CTRL0	Output Control Bit 0. (See Table 1)
3	CTRL1	Output Control Bit 1. (See Table 1)
4	CTRL2	Output Control Bit 2. (See Table 1)
5	ISET	LED current is set by the value of the resistor RSET connected from the ISET pin to ground. Do not short the ISET pin. VISET is typically 1.1V.
6	VOUT	Output Voltage Source for connection to the LED anodes.
7	VIN	Power Input Voltage
8	C1P	Positive Terminal of Bucket Capacitor 1
9	C1N	Negative Terminal of Bucket Capacitor 1
10	C2N	Negative Terminal of Bucket Capacitor 2
11	C2P	Positive Terminal of Bucket Capacitor 2
12	GND	Ground.
13 to 16	LED1 to 4	Current Sink for LED. (If not in use, pin should be connected to VOUT)
Exp. Pad	GND	Exposed pad should be soldered to PCB board and connected to GND.

Block Diagram
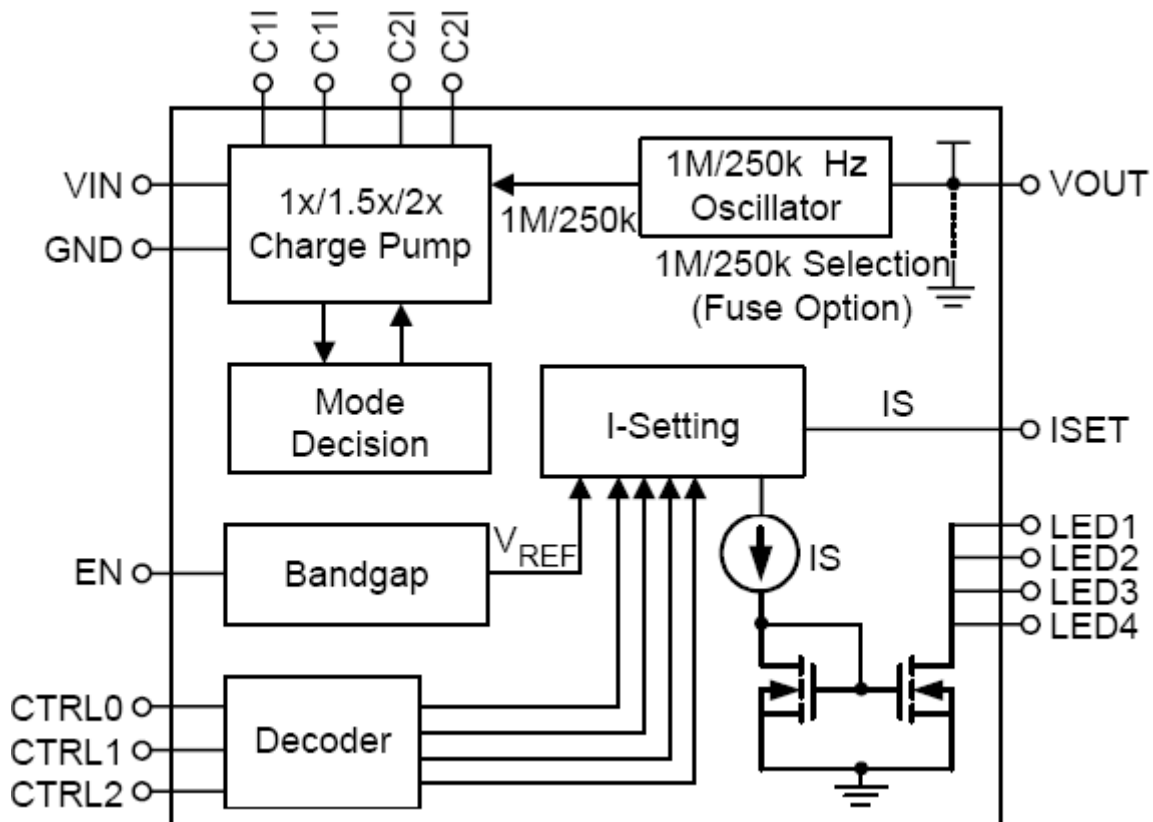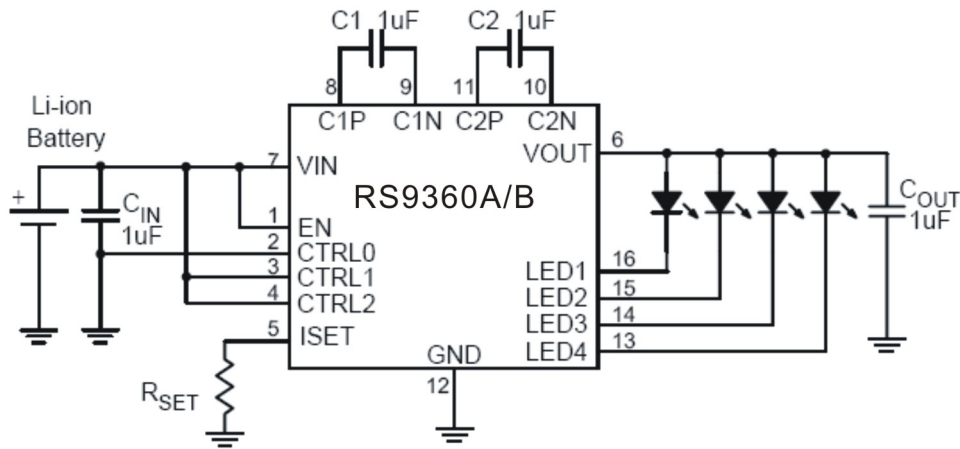
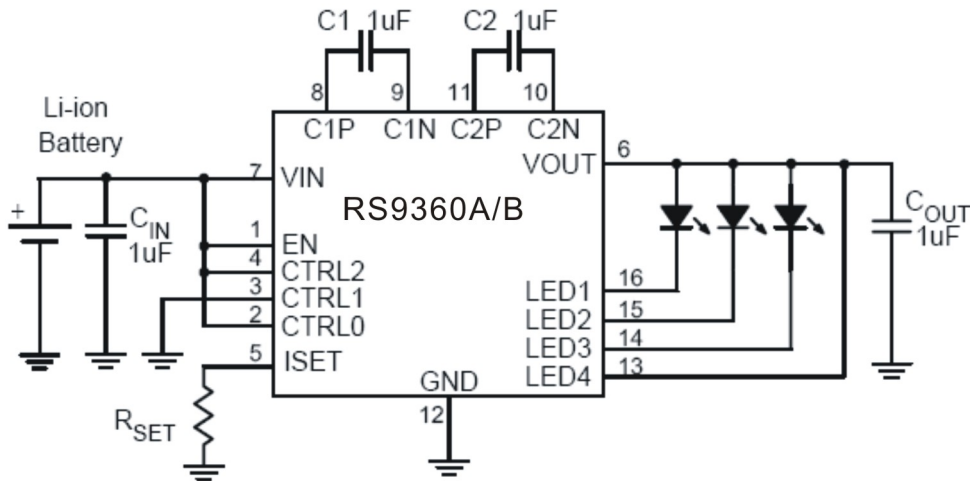## Typical Application Circuit

Fig.1 For 4-WLEDs Application Circuit
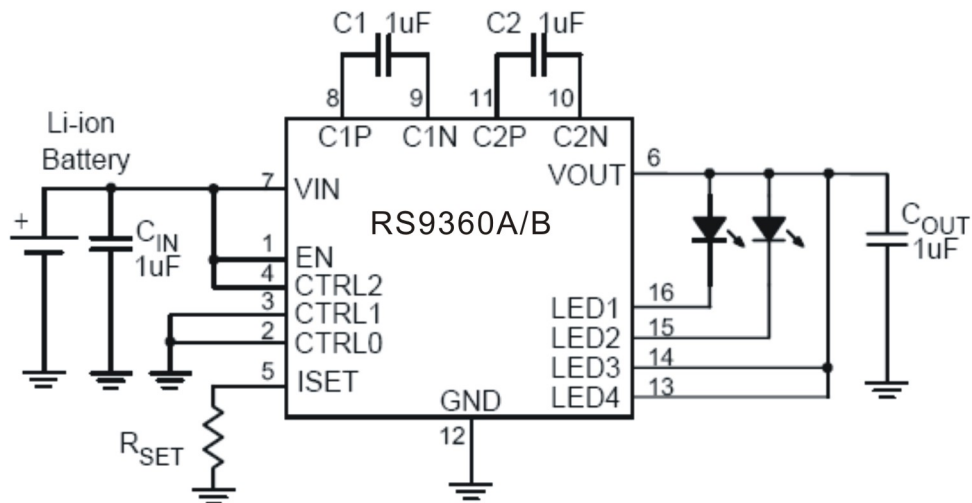

Fig.2 For 3-WLEDs Application Circuit

Fig.3 For 2-WLEDs Application Circuit

Absolute Maximum Rating

Parameter	Symbol	Value	Unit
Input Voltage	VIN	-0.3~6	V
Output Voltage	VOUT	-0.3~6	V
Power Dissipation (QFN-16L 4X4) @ 25 ^{o}C	P_D	2.5	W
Maximum Junction Temperature	T_J	125	^{o}C
Lead Temperature	T_{-LEAD}	260	^{o}C
Operating Temperature Range	T_{OPR}	-40 to + 85	^{o}C
Storage Temperature Range	T_{STG}	-40 to + 85	^{o}C
HBM ESD	ESD	2000	V

Caution: The absolute maximum ratings are rated values exceeding which the product could suffer physical damage. These values must therefore not be exceeded under any condition.

Operations

The RS9360 is a high efficiency charge pump white LED driver. It provides 4 channels low drop-out voltage current source to regulated 4 white LEDs current. For high efficiency, the RS9360 implements x1/x1.5/x2 mode charge pump. An external RSET is used to set the current of white LED. RS9360 has a input current regulation to reduce the input ripple.

Soft Start

The RS9360 includes a soft start circuit to limit the inrush current at power on and mode switching. Soft start circuit holds the input current level long enough for output capacitor COUT reaching a desired voltage level. When the soft start off, the RS9360 won't sink spike current from VIN.

Mode Decision

The RS9360 uses a smart mode decision method to select the working mode for maximum efficiency. Mode decision circuit senses the output and LED voltage for up/down selection.

Dimming Control

CTRL0, CTRL1 and CTRL2 are used to control the onoff of White LED. When a external PWM signal is connected to the control pin, brightness of white LED is adjusted by the duty cycle.

LED Current Setting

The current of white LED connected to RS9360 can be set by RSET. Every current flows through the white LED is 440 times greater than the current of RSET. The white LED can be estimated by following equation:

$$I_{LED} = 440 \times \left(\frac{V_{ISET}}{R_{SET}} \right)$$

When V_{ISET} = 1.1V, and R_{SET} is the resistance connected from I_{SET} to GND.

Thermal Shutdown

The RS9360 provides a high current capability to drive 4 white LEDs. A thermal shutdown circuit is needed to protect the chip from thermal damage. When the chip reaches the shutdown temperature 150℃, the thermal shutdown circuit turns off the chip to prevent the thermal accumulation in the chip.

Overvoltage Protection

The RS9360 regulates the output voltage by controlling the input current. When the output voltage reaches the designated level, the RS9360 reduces the input current. And then, the output voltage regulation also serves an over-voltage protection.

Short Circuit Protection

A current limiting circuit is also included in theRS9360 for short circuit protection. Whenever output source a dangerously high current, the current limiting circuit takes over the output regulation circuit and reduces the output current at an acceptable level.

Table 1

| Control Inputs			Output Status			
CTRL 2	CTRL 1	CTRL 0	LED 4	LED 3	LED 2	LED 1
0	0	0	OFF	OFF	OFF	ON
0	0	1	OFF	OFF	ON	OFF
0	1	0	OFF	ON	OFF	OFF
0	1	1	ON	OFF	OFF	OFF
1	0	0	OFF	OFF	ON	ON
1	0	1	OFF	ON	ON	ON
1	1	0	ON	ON	ON	ON
1	1	1	OFF	OFF	OFF	OFF

Electrical Characteristics

(Ta=25°C, V_{IN} =2.85-5.5V, C1=C2=1.0μF, ESR=0.03Ohms, unless otherwise noted.**)**

Parameter		Symbol	Test Condition	Min.	Typ.	Max.	Unit
Input Supply Voltage		VIN		2.5		5.5	V
Undervoltage Lockout Threshold			VIN rising	1.8	2.2	2.4	V
Undervoltage Lockout Hysteresis				--	50	--	mV
Current into LEDs 1, 2, 3 and 4		I_{LED}	RSET = 24kΩ	18.5	20	21.5	mA
			RSET = 91kΩ	4.5	5	5.5	mA
			2.7V < VIN < 5.5V	2	--	20	mA
			3.1V < VIN < 5.5V	2	--	30	mA
Quiescent Current	RS9360A	I_Q	F_{OSC}=250KHz, EN = High, No Load	--	2.5	3.5	mA
	RS9360B		F_{OSC}=1MHz, EN = High, No Load	--	2.5	3.5	mA
	RS9360A/B		VIN = 4.2V, EN = Low	--	1	10	μA
I_{LED} Accuracy (Note 5)		ILED-ERR	2mA < ILED < 30mA	--	2	7.5	%
Current Matching (Note 6)		ILED-LED-ERR	2mA < ILED < 30mA	--	1	5	%
1x mode to 1.5x mode Transition Voltage (VIN falling)		$V_{TRANS1X}$	V_{LED}= 3.5V, IOUT=80mA ILED1 = ILED2 = ILED3 = ILED4 = 20mA	--	3.75	3.85	V
1.5x mode to 2x mode Transition Voltage (VIN falling)		$V_{TRANS1.5X}$	VLED= 3.5V, IOUT= 80mA ILED1 = ILED2 = ILED3 = ILED4 = 20mA	--	2.85	2.95	V
Oscillator Frequency		F_{OSC}	RS9360A	200	250	300	kHz
			RS9360B	0.8	1.0	1.2	MHz
Input Current Limit		I_{LIMIT}	Short Circuit applied from VOUT to GND	250	400	650	mA
Output Over Voltage Protection		V_{OVP}	Open circuit at any LED that is programmed to be in the on state	--	5.5	6	V

QFN-16L 4x4 Dimension

QFN-16 (4x4x0.75mm)

TOP VIEW
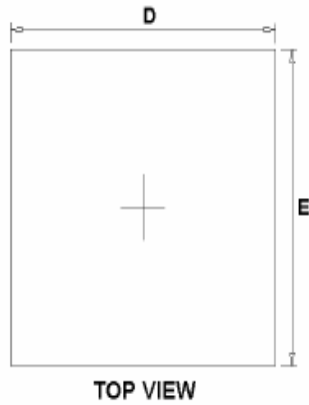
SYMBOLS	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	0.700	0.800	0.028	0.031
D	3.900	4.100	0.154	0.161
E	3.900	4.100	0.154	0.161
D1	2.000	2.200	0.079	0.087
E1	2.000	2.200	0.079	0.087
G	0.153	0.253	0.006	0.010
G1	0.000	0.050	0.000	0.002
L	0.450	0.650	0.018	0.026
b	0.250	0.350	0.010	0.014
e	0.600	0.700	0.024	0.028

FRONT VIEW

BOTTOM VIEW
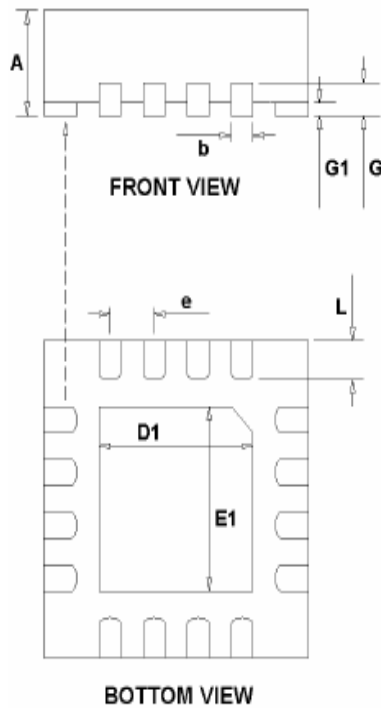
Ordering Information

Part Number	Package
RS9360AQNP	QFN-16L 4x4
RS9360BQNP	QFN-16L 4x4

Soldering Methods for Orister's Products

1. Storage environment: Temperature=10°C~35°C Humidity=65%±15%

2. Reflow soldering of surface-mount devices

Figure 1: Temperature profile
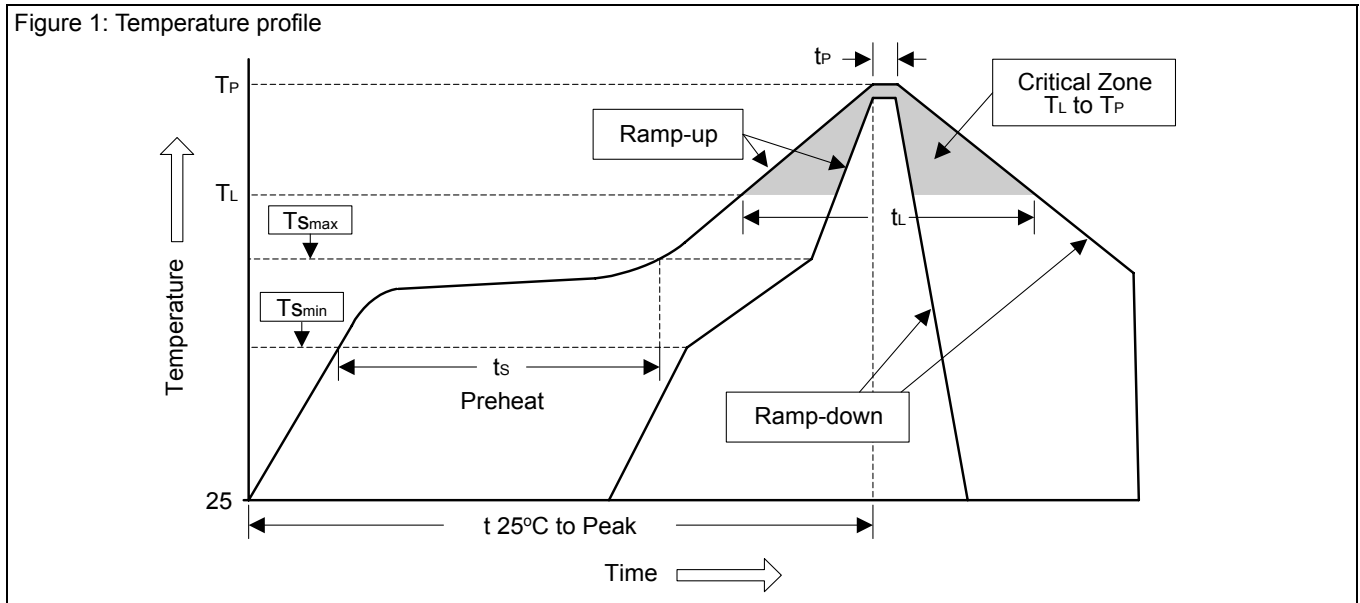
Profile Feature	Sn-Pb Eutectic Assembly	Pb-Free Assembly
Average ramp-up rate (T_L to T_P)	<3°C/sec	<3°C/sec
Preheat - Temperature Min (Ts_{min}) - Temperature Max (Ts_{max}) - Time (min to max) (ts)	100°C 150°C 60~120 sec	150°C 200°C 60~180 sec
Tsmax to T_L - Ramp-up Rate	<3°C/sec	<3°C/sec
Time maintained above: - Temperature (T_L) - Time (t_L)	183°C 60~150 sec	217°C 60~150 sec
Peak Temperature (T_P)	240°C +0/-5°C	260°C +0/-5°C
Time within 5°C of actual Peak Temperature (t_P)	10~30 sec	20~40 sec
Ramp-down Rate	<6°C/sec	<6°C/sec
Time 25°C to Peak Temperature	<6 minutes	<8 minutes

3. Flow (wave) soldering (solder dipping)

Products	Peak temperature	Dipping time
Pb devices.	245°C ±5°C	5sec ±1sec
Pb-Free devices.	260°C +0/-5°C	5sec ±1sec